ENVIRONMENTAL RESOURCES DOCUMENT

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*EOS-End of Section

**May be accessed at http://osat-ext.grc.nasa.gov/emo/pub/PSMS/Volume%20I/A1-2/A2-LewisPlntsMapClr2.pdf

***May be accessed at http://osat-ext.grc.nasa.gov/emo/pub/PSMS/Volume%20II/psms-vol2.pdf (p. 77)

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LIST OF ACRONYMS

AAPL - Aeroacoustic Propulsion Lab
ACRT - Appraisal Consulting Research Training, Inc.
ACTS - Advanced Communications Technology Satellite
ALP - Airport Layout Plan
AOC - Area of Concern
AP/EPP - Affirmative Procurement/Environmentally Preferable Purchasing
APHIS - Animal and Plant Health Inspection Service

CAA - Clean Air Act
CAAA - Clean Air Act Amendments
CEQ - Council on Environmental Quality
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CESU - Cooperative Ecological Studies Unit
CFC - Chlorofluorocarbon
CFR - Code of Federal Regulations
CHIA - Cleveland Hopkins International Airport
CSU - Cleveland State University
CWA - Clean Water Act
CY - Calendar Year

dB - Decibel
dB(A) - Decibel, A-scale
DNAP - Division of Natural Areas and Preserves

EA - Environmental Assessment
ECT - Environmental Compliance Team
EIS - Environmental Impact Statement
EMO - Environmental Management Office, Glenn Research Center
EMS - Environmental Management System
EO - Executive Order
EPCB - Environmental Pollution Control Board, Glenn Research Center
EPCRA - Emergency Planning and Community Right-to-Know Act
EPM – Environmental Programs Manual
EPP - Emergency Preparedness Plan
ERB - Engine Research Building
ERD - Environmental Resources Document

FAA - Federal Aviation Administration
FEIS - Final Environmental Impact Statement
FEMA - Federal Energy Management Agency
FGDC - Federal Geographic Data Committee
FIFRA - Federal Insecticide, Fungicide, and Rodenticide Act
FIRM - Flood Insurance Rate Maps
FPPA - Farmland Protection Policy Act
FS - Feasibility Study
FUDS - Formerly Utilized Defense Sites
FY - Fiscal Year

GAC – Granular Activated Carbon
gpm - Gallons Per Minute
GRC - Glenn Research Center
GtG - Greening the Government
GS - General Schedule

HAER - Historic American Engineering Record
HAP - Hazardous Air Pollutant
HCFC - Hydrochlorofluorocarbon
HTF - Hypersonic Tunnel Facility

IWS - Industrial Waste Sewer

kph -Kilometers per hour
kW - Kilowatt

LeRC - Lewis Research Center
LIFT - Lewis Incubator for Technology
lpd - Liters Per Day
lpm - Liters Per Minute
LS - Limestone
LTID - Logistics and Technical Information Division

MACT - Maximum Achievable Control Technology
MCF -A measure equaling 1,000 cubic feet
MER - Mars Exploration Rover
mg/l - Milligrams Per Liter
mrem - Millirem
MS4 - Municipal Separate Storm Sewer System
MSDS - Material Safety Data Sheet
MWh -Megawatt Hour
MW - Megawatt

NAAQS - National Ambient Air Quality Standards
NACA- National Advisory Committee for Aeronautics
NAICS - North American Industrial Classification System
NASA - National Aeronautics and Space Administration
NEORSD - Northeast Ohio Regional Sewer District
NEPA - National Environmental Policy Act
NERVA - Nuclear Engine for Rocket Vehicle Application
NESHAP - National Emissions Standards for Hazardous Air Pollutants
NHL - National Historic Landmark
NHPA - National Historic Preservation Act
NOI - Notice of Intent
NOx - Nitrogen Oxides
NPD - NASA Policy Directive
NPDES - National Pollutant Discharge Elimination System
NPG - NASA Procedures and Guidelines
NRC - Nuclear Regulatory Commission

OAC - Ohio Administrative Code
OAI - Ohio Aerospace Institute
ODNR - Ohio Department of Natural Resources
ODS - Ozone Depleting Substances
Ohio EPA - Ohio Environmental Protection Agency
OSHA - Occupational Safety and Health Administration or Act

P2 - Pollution Prevention
PA/VSI - Preliminary Assessment/Visual Site Inspection
PBMO - Plum Brook Management Office
PBOW - Plum Brook Ordnance Works
PBRF - Plum Brook Reactor Facility
PBS - Plum Brook Station
PCBs - Polychlorinated Biphenyls
POTW - Publicly Owned Treatment Works
PPM - Parts Per Million
PPOA - Pollution Prevention Opportunity Assessment
PSL - Propulsion Systems Lab
PTE - Potential To Emit
PTI - Permit To Install
PTO - Permit To Operate

R&D - Research and Development
RBCC - Rocket Based Combined Cycle
RCRA - Resource Conservation and Recovery Act
RETF - Rocket Engine Test Facility
RI - Remedial Investigation
RSO - Radiation Safety Officer

SAAD - Safety and Assurance Directorate
SAIC - Science Applications International Corporation
SD - Sustainable Design
SH - Shale
SHPO - State Historic Preservation Officer
SPEAR - Space Electronically Agile Radar
SPCC - Spill Prevention Control and Countermeasure
SPF - Space Power Facility
SPFWWTP - Space Power Facility Wastewater Treatment Plant
STP - Shovel Test Pit
SVOC – Semi-Volatile Organic Compound
SWMU - Solid Waste Management Unit
SWP3 - Storm Water Pollution Prevention Plan

TNC – The Nature Conservancy
TRI - Toxics Release Inventory
TSCA - Toxic Substance Control Act

USACE - US Army Corps of Engineers
USC - United States Code
USDA - United States Department of Agriculture
USEPA - United States Environmental Protection Agency
USGS - United States Geological Survey
UST - Underground Storage Tank

VAP - Voluntary Action Program
VEGE – Vacuum-enhanced Groundwater Extraction
VOC - Volatile Organic Compound

WMT - Waste Management Team

CONVERSION FACTORS

Distance

1 centimeter (cm) = 0.3937 inches, 1 inch = 2.540 cm

1 meter (m) = 3.281 feet, 1 foot = 0.3048 m

1 kilometer (km) = 0.6214 miles (mi.), 1 mi = 1.609 km

1 kilometer = 0.5396 nautical miles (NM), 1 NM = 1.853 km

Area

1 square cm = 0.1550 square inches, 1 in^2 = 6.452 cm^2

1 square m = 10.76 square feet, 1 ft^2 = 0.09290 m^2

1 square km = 0.3861 square miles, 1 mi^2 = 2.590 km^2

1 hectare (ha) = 2.471 acres, 1 acre = 0.4047 ha

Volume

1 cubic cm = 0.06102 cubic inches, 1 in^3 = 16.39 cm^3

1 cubic m = 35.31 cubic feet, 1 ft^3 = 0.02832 m^3

1 liter (l) = 1.057 quarts, 1 quart = 0.9464 l

1 liter = 0.2642 gallons, 1 gallon = 3.785 l

Weight

1 gram (g) = 0.03527 ounces, 1 oz = 28.35 g

1 kilogram (kg) = 2.205 pounds (lbs), 1 lb = 0.4536 kg

1 metric ton (mt) = 1.102 short tons, 1 short ton= 0.9072 mt

Thrust, Energy, Pressure

1 pound = 4.448 Newtons (N), 1 N = 0.2248 lb

1 joule (j) = 9.480E-4 British Thermal Units (BTU), 1 BTU = 1055 j

1 kg/m^2 = 0.2048 $pounds/ft^2$, 1 lb/ft^2 = 4.882 kg/m^2

Temperature

^{o} C = (5/9) (^{o} F-32), ^{o} F = 1.8 ^{o} C + 32.

Source: Derived primarily from the Merck Index, Eleventh Edition, Merck & Co., Inc. 1989.

PART A – GLENN RESEARCH CENTER AT LEWIS FIELD

A1 DESCRIPTION OF GLENN RESEARCH CENTER

A1.a Description of the Center

The Glenn Research Center in Cleveland, Ohio was established in 1941 as the Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics (NACA). In 1958, NACA was reorganized into NASA and the laboratory became part of the new organization, at the time called Lewis Research Center. On March 1, 1999, the Lewis Research Center was officially renamed the NASA John H. Glenn Research Center (GRC) at Lewis Field.

On-site technical and support facilities have changed continuously throughout the years and the campus-like setting now includes a diverse array of laboratories, office buildings, research and test stations, and support facilities.

At its Cleveland site, NASA owns or leases 147.62 hectares (364.49 acres). The site is located in western Cuyahoga County, Ohio and is predominantly within the limits of the City of Brook Park, approximately twenty miles southwest of downtown Cleveland. A small part of the site to the north is located in the City of Fairview Park. The site borders the Cleveland Hopkins International Airport to the east. To the north and west is the Rocky River Reservation, a part of the Cleveland Metropolitan Park District (Metroparks). The southern boundary of the site is adjacent to residential and business districts of the City of Brook Park, including the Aerospace Technology Park office development (Figure A1-1 Fold-out Map of Lewis Field Site insert at end of this section).

The site lies between latitudes 41°24' and 41°25'30"N, and longitudes 81°51' and 81°53"W. The location can be found on the United States Geological Survey (USGS) 7.5 minute-series topographic map for the Lakewood Quadrangle (41081-D7-TF-024).

A1.b GRC Lewis Field Facilities

The Lewis Field site is organized administratively into four geographic areas. The North Area is the land north of Brookpark Road. This contains two administrative buildings and a parking lot.

The Central Area is the largest portion and contains the greatest concentration of buildings and many of the major test facilities. The Central Area contains specialized facilities, which supply altitude exhaust, compressed air, and cooling water. These systems are essential to a number of test operations and therefore combustion-related experiments are normally clustered here. The Central Area is bordered by Brookpark Road to the north, the Airport to the east, and Cedar Point Road to the southwest.

The South Area contains the Rocket Engine Test Facility, the Central Chemical Storage Facility, bulk storage areas, and other facilities requiring a buffer zone. The South Area is the portion of the site south of Cedar Point Road. The bulk of the property in the South Area is scheduled to be transferred to the City of Cleveland for the Cleveland Hopkins International Airport Expansion.

The West Area is separated from the Central Area by Abram Creek and includes the Electric Power Laboratory, Energy Conversion Laboratory, Power Systems Facility, Management Conference Building (Guerin House), recreational areas, the day care center, the fitness center, and other facilities.

The November, 2002 GRC *Real Property Report* lists 180 buildings, structures, and other facilities at Lewis Field including many specialized Research and Development (R&D) facilities (Table A1-1). The capital cost of all Lewis Field facilities is given as $507 million, with a replacement cost of $1.73 billion. The total facility gross square footage (measured from outside wall to outside wall) is 262,472 square meters (2.8 million square feet). The November, 2002 *Facilities Utilization Report* gives the "allocated net usable area" as approximately 204,387 square meters (2.2 million square feet). The largest percentages of this space are technical facilities (38%), office space (19%), and laboratories (13%).

GRC has many unique test facilities for conducting wind tunnel, aeronautics, propulsion, space power, and advanced research. The specialized facilities at GRC are used to support NASA's research, technology, and development programs in the areas of aero-propulsion, space flight systems, space propulsion, space science applications, and space power. More detailed information on the technical capabilities of these facilities can be found at http://facilities.grc.nasa.gov/index.html. Highlights among these facilities are listed in Table A1-1.

Table A1-1 Unique Facilities at Lewis Field

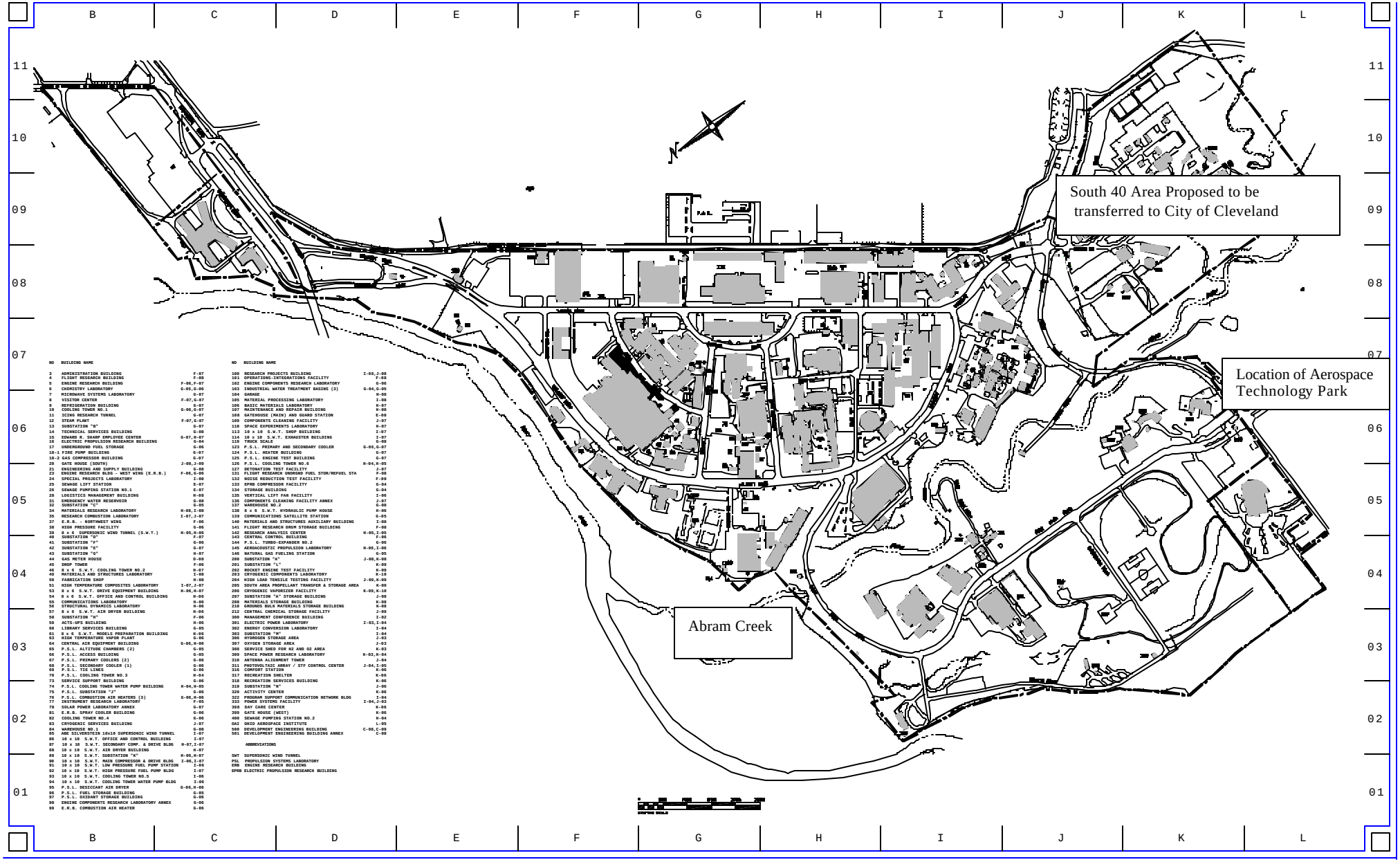
FACILITY	LOCATION
1'x1' Supersonic Wind Tunnel	Building 5
8' X 6' / 9' X 15' Supersonic/Transonic Wind Tunnels	Building 39
10' X 10' Abe Silverstein Supersonic Wind Tunnel	Building 85
Acoustical Test Laboratory	Building 333
Advanced Computational Concepts Laboratory	Building 142
Advanced Subsonic Combustion Rig	Building 38
Icing Research Tunnel	Building 11
Propulsion Systems Laboratory	Building 125
Engine Research Building	Building 5
Engine Components Research Laboratory	Building 102
Electric Propulsion Research Building	Building 16
Aero-acoustic Propulsion Laboratory	Building 145
Research Combustion Laboratory	Building 35
Space Experiments Laboratory	Building 110
Structural Dynamics Laboratory	Building 56
Drop Tower	Building 45
Electric Power Laboratory	Building 301
Energy Conversion Laboratory	Building 302
Space Power Research Laboratory	Building 309
Microgravity Operations-Integrations Facility	Building 4
Fuel Cell Research Building	Building 334

NASA GRC is also a major supporter of the Ohio Aerospace Institute (OAI). OAI was founded in 1989 as a not-for-profit consortium of Federal laboratories in Ohio (GRC and Wright-Patterson Air Force Base), nine Ohio universities, and high-technology aerospace companies. OAI's mission is to facilitate collaboration among the university, industry, and government sectors to enhance local and national economic competitiveness. OAI's 6,500 square meter (70,000 square foot) building opened in 1992 and is located on 3.8 hectares (9.5 acres) of land leased from GRC outside the security fence southwest of the main site.

Facilities and structures at GRC Lewis Field are constantly changing. Due to the Cleveland Hopkins International Airport Expansion Project, a number of GRC facilities are being relocated or demolished and rebuilt. The Rocket Engine Test Facility is being demolished and replaced with the Altitude Combustion Stand to be located in the West Central Area of GRC. The Supplemental Multi-Layer Interface Research Facility (SMiRF) is to be replaced with the Creek Road Complex. The Cryogenic Components Laboratory is in the process of being razed and will be rebuilt at Plum Brook Station. The Central Chemical Storage Facility, Child Care Facility, and Fitness Center are all being relocated to accommodate the expansion project.

A1.c Lewis Field Tenant Agencies

The United States Army has 48 employees on site as part of the Vehicle Technology Directorate. This group has been on-site for over 30 years and works with NASA staff on joint ventures involving propulsion and ground vehicle engines and transmissions.



NO	BUILDING NAME	
3	ADMINISTRATION BUILDING	F-07
4	FLIGHT RESEARCH BUILDING	F-08
5	ENGINE RESEARCH BUILDING	F-06,F-07
6	CHEMISTRY LABORATORY	G-05,G-06
7	MICROWAVE SYSTEMS LABORATORY	G-07
8	VISITOR CENTER	F-07,G-07
9	REFRIGERATION BUILDING	G-07
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11	ICING RESEARCH TUNNEL	G-07
12	STEAM PLANT	F-07,G-07
13	SUBSTATION "B"	G-07
14	TECHNICAL SERVICES BUILDING	H-08
15	EDWARD R. SHARP EMPLOYEE CENTER	G-07,H-07
16	ELECTRIC PROPULSION RESEARCH BUILDING	G-04
17	UNDERGROUND FUEL STORAGE	G-06
18-1	FIRE PUMP BUILDING	G-07
18-2	GAS COMPRESSOR BUILDING	G-07
20	GATE HOUSE (SOUTH)	J-08,J-09
21	ENGINEERING AND SUPPLY BUILDING	G-08
23	ENGINE RESEARCH BLDG - WEST WING (E.R.B.)	F-06,G-08
24	SPECIAL PROJECTS LABORATORY	I-06
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26	SEWAGE PUMPING STATION NO.1	G-07
28	LOGISTICS MANAGEMENT BUILDING	H-08
31	EMERGENCY WATER RESERVOIR	G-08
32	SUBSTATION "C"	G-05
34	MATERIALS RESEARCH LABORATORY	H-08,I-08
35	RESEARCH COMBUSTION LABORATORY	I-07,J-07
37	E.R.B. - NORTHWEST WING	F-06
38	HIGH PRESSURE FACILITY	G-06
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40	SUBSTATION "D"	F-07
41	SUBSTATION "I"	G-06
42	SUBSTATION "E"	G-07
43	SUBSTATION "G"	H-07
44	GAS METER HOUSE	D-08
45	DROP TOWER	F-06
46	8 x 6 S.W.T. COOLING TOWER NO.2	H-07
49	MATERIALS AND STRUCTURES LABORATORY	I-08
50	FABRICATION SHOP	H-08
51	HIGH TEMPERATURE COMPOSITES LABORATORY	I-07,J-07
53	8 x 6 S.W.T. DRIVE EQUIPMENT BUILDING	H-06,H-07
54	8 x 6 S.W.T. OFFICE AND CONTROL BUILDING	H-06
55	COMMUNICATIONS LABORATORY	H-06
56	STRUCTURAL DYNAMICS LABORATORY	H-08
57	8 x 6 S.W.T. AIR DRYER BUILDING	H-06
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59	ACTS-UPS BUILDING	H-06
60	LIBRARY SERVICES BUILDING	H-08
61	8 x 6 S.W.T. MODELS PREPARATION BUILDING	H-06
63	HIGH TEMPERATURE VAPOR PLANT	G-08
64	CENTRAL AIR EQUIPMENT BUILDING	G-06,H-06
65	P.S.L. ALTITUDE CHAMBERS (2)	G-05
66	P.S.L. ACCESS BUILDING	G-05
67	P.S.L. PRIMARY COOLERS (2)	G-06
68	P.S.L. SECONDARY COOLER (1)	G-06
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89	10 x 10 S.W.T. SUBSTATION "K"	H-06,H-07
90	10 x 10 S.W.T. MAIN COMPRESSOR & DRIVE BLDG	I-06,I-07
91	10 x 10 S.W.T. LOW PRESSURE FUEL PUMP STATION	I-06
92	10 x 10 S.W.T. HIGH PRESSURE FUEL PUMP BLDG	I-07
93	10 x 10 S.W.T. COOLING TOWER NO.5	I-06
94	10 x 10 S.W.T. COOLING TOWER WATER PUMP BLDG	I-06
95	P.S.L. DESICCANT AIR DRYER	G-06,H-06
96	P.S.L. FUEL STORAGE BUILDING	G-05
97	P.S.L. OXIDANT STORAGE BUILDING	G-06
98	ENGINE COMPONENTS RESEARCH LABORATORY ANNEX	G-06
99	E.R.B. COMBUSTION AIR HEATER	G-06

NO	BUILDING NAME	
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102	ENGINE COMPONENTS RESEARCH LABORATORY	G-06
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106	BASIC MATERIALS LABORATORY	H-07
107	MAINTENANCE AND REPAIR BUILDING	H-06
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109	COMPONENTS CLEANING FACILITY	J-07
110	SPACE EXPERIMENTS LABORATORY	H-07
113	10 x 10 S.W.T. SHOP BUILDING	I-07
114	10 x 10 S.W.T. EXHAUSTER BUILDING	I-07
119	TRUCK SCALE	G-08
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124	P.S.L. HEATER BUILDING	G-07
125	P.S.L. ENGINE TEST BUILDING	G-07
126	P.S.L. COOLING TOWER NO.6	H-04,H-05
127	DETONATION TEST FACILITY	J-07
131	FLIGHT RESEARCH HYDROGEN FUEL STOR/REFUEL STA	F-08
132	NOISE REDUCTION TEST FACILITY	F-09
133	EPBD COMPRESSOR FACILITY	G-04
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138	8 x 6 S.W.T. HYDRAULIC PUMP HOUSE	H-06
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308	SERVICE SHED FOR N2 AND O2 AREA	K-03
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316	COMFORT STATION	K-05
317	RECREATION SHELTER	K-04
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399	GATE HOUSE (WEST)	K-06
400	SEWAGE PUMPING STATION NO.2	H-04
042	OHIO AEROSPACE INSTITUTE	L-05
500	DEVELOPMENT ENGINEERING BUILDING	C-08,C-09
501	DEVELOPMENT ENGINEERING BUILDING ANNEX	C-08

ABBREVIATIONS

SWT	SUPERSONIC WIND TUNNEL
PSL	PROPULSION SYSTEMS LABORATORY
ERB	ENGINE RESEARCH BUILDING
EPBD	ELECTRIC PROPULSION RESEARCH BUILDING

Figure A1-1 Map of Lewis Field Site

A2 AIR RESOURES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to air pollution and its control. Relevant chapters include:

- Chapter 4 Air Pollution Control
- Chapter 26 Ozone Depleting Chemicals

A2.a Climate

The climate at the Lewis Field site is continental in character, but strongly influenced by Lake Erie which is 8 kilometers (5 miles) to the north. Lake Erie tends to moderate temperature extremes and increase overall precipitation. Summers are warm and humid, with average temperatures of 21° C (70° F) (ODNR, 1996), occasionally exceeding 32° C (90° F) but rarely 38° C (100° F). The first frost typically occurs in October. Winters are relatively cold and cloudy, with an average temperature of -2° C (29° F).

Precipitation varies substantially from year to year. Between 1961 and 1990, precipitation averaged 89 centimeters (35 inches) per year. Some 60 percent of this precipitation falls between April and September (ODNR, 1996). Thunderstorms can occur from April through August. Snowfall averages 114 centimeters (45 inches) in the vicinity of Lewis Field (Warner/Osborn/Pardee, 1990), but can be double that amount in the "snow belt" areas at the eastern end of the County. Average annual free water surface evaporation for the region is 82.65 centimeters (32.54 inches) (ODNR, 1972).

Prevailing winds are from the south to southwest (National Oceanic and Atmospheric Administration, 1990). Westerly winds blowing across the lake can produce a lake effect near the shore. The cooling winds can delay spring in these areas. Winds are more westerly during the winter months. Some storms originating over the Lake can be violent, however, tornadoes are rare in the Cleveland area. Atlantic Coast hurricanes generally dissipate in strength before their effects are felt in northern Ohio. More detailed climatological data for Lewis Field can be obtained from the National Weather Service.

A2.b Local Air Quality

The City of Cleveland conducts air monitoring for Cuyahoga County which tracks carbon monoxide, nitrogen oxide, nitrogen dioxide, sulfur dioxide, particulate matter (PM-10), total suspended particulates, ozone, and toxic air pollutants. As of this writing, Cuyahoga County is designated as an attainment area, though changing conditions and regulations may influence this designation in the future. The National Ambient Air Quality Standards are listed in Table A2-1. Current air quality information may be obtained from the Ohio Environmental Protection Agency, located on-line at http://airohio.epa.state.oh.us/.

Table A2-1 National Ambient Air Quality Standards

POLLUTANT	STANDARDVALUE *		STANDARDTYPE
Carbon Monoxide (CO)			
8-hour Average	9 ppm	(10 mg/m^3)	Primary
1-hour Average	35 ppm	(40 mg/m^3)	Primary
Nitrogen Dioxide (NO_2)			
Annual Arithmetic Mean	0.053 ppm	(100 µg/m^3)	Primary & Secondary
Ozone (O_3)			
8-hour Average	0.08 ppm	(157 µg/m^3)	Primary & Secondary
1-hour Average	0.12 ppm	(235 µg/m^3)	Primary & Secondary
Lead (Pb)			
Quarterly Average	1.5 µg/m^3		Primary & Secondary
Particulate (PM 10) *Particles with diameters of 10 micrometers or less*			
Annual Arithmetic Mean	50 µg/m^3		Primary & Secondary
24-hour Average	150 µg/m^3		Primary & Secondary
Particulate (PM 2.5) *Particles with diameters of 2.5 micrometers or less*			
Annual Arithmetic Mean	15 µg/m^3		Primary & Secondary
24-hour Average	65 µg/m^3		Primary & Secondary
Sulfur Dioxide (SO_2)			
Annual Arithmetic Mean	0.030 ppm	(80 µg/m^3)	Primary
24-hour Average	0.14 ppm	(365 µg/m^3)	Primary
3-hour Average	0.50 ppm	(1300 µg/m^3)	Secondary

* Parenthetical value is an approximately equivalent concentration.

A2.c Stationary Sources

Lewis Field has an assigned Ohio EPA air program facility identification number, 1318001169. The NAICS code is 927110 for NASA (Space Research and Technology). Stationary on-site emission sources include boilers, heaters, research test cells, and many additional insignificant and trivial sources. The boilers housed in the steam plant represent the largest actual emission source at Lewis Field. The various research combustion sources represent the largest potential emission sources at Lewis Field.

As of this writing, the Lewis Field facility is classified as a minor source under Title III and a major source under Title V of the CAAA. Accordingly, Lewis Field prepared a Title V permit application using the Ohio EPA-mandated STARship computer software. This application was submitted to the regulatory authorities on September 24, 1996. Since this date the Center has operated and continues to maintain its

operations under a Permit Shield. This Permit Shield covers the Center until the final Title V Operating Permit can be issued. As of this writing, the permit application has undergone regulatory review and a draft Title V Operating Permit has been issued. After a Title V Operating Permit is issued it must be renewed at least once every five years. As of this writing, Lewis Field has no applicable National Emission Standards for Hazardous Air Pollutants regulations. There are also no listed toxic, flammable or explosive substances in excess of the threshold quantities requiring a Risk Management Plan.

The electronic Title V Operating Permit application includes all sources classified as "non-insignificant" and "insignificant". Non-insignificant sources at Lewis Field are listed in Table A2-2. A third classification of "trivial" sources need not be included in the Title V Operating Permit application. Emissions from these sources result from the combustion of fuels including natural gas, #2 fuel oil, and jet fuels. Estimated actual emissions, based on the Emission Fee Report for 2001, are: 1 ton of particulates, 1 ton of sulfur dioxide, 28 tons of nitrogen oxides, 1 ton of organic compounds, and 9 tons of carbon monoxide annually.

The discrepancy between Lewis Field's theoretically high potential-to-emit and the relatively low actual annual emissions is a result of the nature of research. In this industrial classification, analytical data or "research" is the product, and, as such, is not like manufacturing or mass production. Since each experiment is configured individually the equipment cannot operate 8,760 potential hours per year. In general, the areas with the highest potential to emit take the longest to prepare to operate. In some cases the preparation time may take six months, with the projects being planned years in advance. This type of physical limitation is difficult to quantify for permitting applications. Therefore, these units are often addressed as being capable of operating continuously or are assigned special enforceable limitations. For nearly all of the on-site facilities the operation is theoretically unlimited. That is, the facilities are legally allowed to operate 8,760 hours per year.

A2.d Mobile and Off-Site Sources

On-site vehicles are classified as mobile sources of emissions. Lewis Field vehicles include construction and other heavy vehicles, aircraft, shuttle buses and fleet vehicles owned or operated by Lewis Field. Many of the vehicles operate on natural gas or dual fuels. As of this writing, a bio-diesel program is in the prototype phase. Other air emissions are not generated by Lewis Field directly but are attributable to its operations. These types of emissions would include power plant emissions for Lewis Field's electrical power needs, off-site research activities, and the use of private, commercial and fleet vehicles for business related transportation.

A2.e Ozone-Depleting Substances

NASA Headquarters and GRC have established ozone-depleting substances (ODS) management policies and plan to eliminate the use of these chemicals in all but critical applications. Chapter 26 of the *GRC Environmental Programs Manual* addresses the ODS policy. All ODS are controlled substances at Lewis Field and require special approval before they may be purchased. Larger equipment containing ODS chemicals are monitored and their chemical use is tracked. New refrigeration equipment must be ODS-free whenever possible.

Lewis Field developed specific reduction goals for three chlorofluorocarbon chemicals in compliance with Executive Order 12856 (1993), *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements*. Additionally, Executive Order 12843 (1993), *Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances,* and Executive Order 13148 (2000) *Greening the Government Through Leadership in Environmental Management,* direct Federal agencies to

use alternative chemicals to the extent possible. Lewis Field continues to use ODS chemicals in research, cleaning, cooling and lubricating applications, however, with the current policy, the use of these materials is declining.

Table A2-2 Non-Insignificant Sources

SOURCE NUMBER	DESCRIPTION	COMMENTS
B003 (BOILER03-B012)	Steam generation (boiler #3)	
B004 (BOILER04-B012)	Steam generation (boiler #4)	
B005 (BOILER05-B012)	Steam generation (boiler #5)	
B006 (BOILER06-B301)	Space heating (boiler #6)	
B014 (BOILER01-B012)	Steam generation (boiler #1)	
B015 (BOILER02-B012)	Steam generation (boiler #2)	
B022 (HEAT05-B085)	Wind tunnel air heating	
B023 (HEAT22-B039)	Heat air for wind tunnel testing	
B024 (HEAT25-B099)	Combustion air preheater	
B025 (HEAT26-B124)	Auxiliary natural gas heater #1 for PSL	
B026 (HEAT27-B124)	Auxiliary natural gas heater #2 for PSL	
P001 (HEAT01-B057)	Drying beds	
P011 (CELL06-B024)	Jet engine testing. Replaces permit P006.	
P012 (CELL11A-B035)	Jet engine testing	Reclassified as Insignificant
P014 (CELL23-B035)	Combustion research	
P015 (CELLSW21-B038)	Jet engine testing	
P016 (CELL1B-B102)	Jet engine testing	
P017 (CELL01-B034)	Atmospheric burner rigs	
P018 (CELL01-B145)	Jet engine testing	
P019 (CELL21-B035)	Engine testing	
P020 (CELL01-B085)	Wind tunnel engine testing	
P021 (CELL2A-B102)	Jet engine testing	
P023 (CELL04-B125)	Jet engine testing	
P024 (CELL03-B125)	Jet engine testing	
P901 (HEAT02-B088)	Drying beds	
P903 (CELLCE5B1-B005)	Jet engine testing	
P904 (CELLCE5B2-B005)	Jet engine testing	
P905 (CELLCE9B-A-B005)	Jet engine testing	
P906 (CELLCE9B-B-B005)	Jet engine testing	
P907 (CELLCPRM-B038)	Preheater for jet engine testing	
P908 (CELL01-B124)	Preheater for jet engine testing	
P909 (CELL02-B124)	Preheater for jet engine testing	
P919 (CELL2B-B102)	Jet engine testing	
B020 (HEAT29-B145)	Preheater for AAPL	Being added to Title V Operating Permit
B027 (HEAT28-B124)	Air Heater for PSL	Under PTI
B028 (HEAT29-B05)	Air Heater for ERB Cell CE-5B	Under PTI
B029 (HEAT30-B23)	Air Heater for ERB Cell W-2	Under PTI

A3 WATER RESOURCES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to water pollution control. Relevant chapters include:

- Chapter 3 Water Pollution Control

A3.a Surface Water Hydrology

The primary surface water features at the Lewis Field site are the Rocky River and its tributary, Abram Creek (Figure A3-1). The Rocky River flows along the western edge of the Lewis Field site, separating it from the Rocky River Reservation of the Cleveland Metropolitan Park District. The Ohio EPA lists the drainage area of the Rocky River at 761 square kilometers (294 square miles). The Rocky River is a third-order stream with an average daily discharge rate of 7.8 cubic meters (276 cubic feet) per second, as measured at a USGS gaging station 2.6 kilometers (1.6 miles) upstream from Lewis Field. The 7-day, 10-year low flow is estimated by the USGS to be 0.04 cubic meters (1.4 cubic feet) per second. Wastewater discharges and removals within the basin are significant and result in an effective 7-day, 10-year low flow of 0.87 cubic meters (30.6 cubic feet) per second. After passing Lewis Field, the river flows north approximately 18 kilometers (11 miles) and discharges into Lake Erie. There is no commercial fishing in the Rocky River or its tributaries although there is recreational fishing.

Abram Creek begins in a low-lying area south of Cleveland Hopkins International Airport and flows through a heavily industrialized area, crossing the Lewis Field property. It travels approximately 6 kilometers (4 miles) to its confluence with the Rocky River. Detailed hydrologic data for Abram Creek are not available. Near Lewis Field, both Abram Creek and Rocky River are in narrow, steep valleys, 15 to 30 meters (50 to 100 feet) below the elevation of the main Lewis Field site. No subsistence populations using the Rocky River or Abram Creek have been identified (Jones 1996).

Lake Erie, 8 kilometers (5 miles) to the north, is one of the five Great Lakes. Lake Erie has a surface area of approximately 25,700 square kilometers (9,919 square miles) and an estimated volume of 471 cubic kilometers (113 cubic miles) (SAIC, 1991). The Lake is an important fresh water fishery; with a combined commercial and sport catch estimated to exceed 20 million fish. Lake Erie is also a popular recreational resource for boating and its many beaches.

Most surface water runoff from Lewis Field flows through the storm sewer system and natural swales to Abram Creek and Rocky River. Although most precipitation is believed to flow overland, several low-volume seeps have been observed on the Abram Creek Valley walls after periods of heavy rainfall (SAIC, 1993).

A3.b Surface Water Quality

The Ohio EPA monitors water quality in the Rocky River at several locations. The closest station upstream of Lewis Field is at Cedar Point Road in North Olmsted (Station 501800) and downstream at Rockcliff Road in Lakewood (Station 501790). Both the Rocky River and Abram Creek are classified as Warmwater Habitats by the Ohio EPA and portions of Rocky River are designated as “Seasonal Salmonid” due to the occasional migration of salmon. Other use designations for portions of Abram Creek and Rocky River include Primary Contact Recreation (swimming) and Agricultural and Industrial Water Supply. The Ohio Department of Natural Resources (ODNR) Division of Wildlife stocks the Rocky River with juvenile steelhead salmon each spring. Because the river flows through the Cleveland Metroparks, it is designated as State Resource Water in the vicinity of Lewis Field. The designation affords special protection under the State’s antidegradation policy.

The antidegradation provisions describe the conditions under which water quality may be lowered in surface waters. Existing beneficial uses must be maintained and protected. Further, water quality better than that needed to protect existing beneficial uses must be maintained unless lower quality is deemed necessary to allow important economic or social development (existing beneficial uses must still be protected). Provisions addressing antidegradation are in rule **3745-1-05** and rule **3745-1-54** of the OAC.

Water quality in Rocky River and Abram Creek has improved in the last two decades. Many POTW's have been upgraded. Some have been eliminated in favor of centralized treatment by the North East Ohio Regional Sewer District (NEORSD). Several industries discharging to Abram Creek and Rocky River upstream of Lewis Field have also improved the quality of their discharges. The Ohio EPA Division of Surface Water conducted an intensive survey of Rocky River and its tributaries in 1992 (Ohio EPA, 1993). Although the survey identified few exceedances of acute or chronic water quality criteria, only 3% of the surveyed sections of the river main stem were in full attainment of the warmwater habitat aquatic life use designation. The remaining sections failed one or more of the three biological index criteria. In past years, sporadic exceedances of iron, zinc, and total phosphorous limits have been observed.

A qualitative biotic survey was conducted in 1994 (ACRT, 1994). The survey examined water quality, fish, macroinvertebrates, vertebrates, and plants at Abram Creek and Rocky River in the vicinity of Lewis Field. Both streams displayed signs of environmental degradation, as indicated by the number of taxa, the types of organisms, and the density of organisms found. Conditions worsened on moving upstream. Abram Creek was in worse condition than Rocky River, and the unnamed tributary to Abram Creek more impacted still.

A more quantitative survey of Rocky River and Abram Creek was commissioned in 1995 by the Cleveland Hopkins International Airport (Malcolm Pirnie, 1996). This confirmed earlier studies, which concluded that neither stream met the warmwater habitat criteria. The study indicated that chemical pollutants in the water and sediments were not significant contributors to the degraded condition of the biological communities. Rather, stream flow patterns indicative of highly urbanized storm flow drainage may be important factors in explaining the degradation of stream biota. High peak flows and rapid changes in flow lead to unstable streambeds, resulting in periodic disturbance of the habitat.

A3.c Groundwater

Groundwater is little used in the vicinity of the Lewis Field site. Consequently, less information is available for groundwater than surface water. Groundwater is said to occur in two distinct lithologic zones, in the shale bedrock and in perched lenses in the overlying unconsolidated materials. Of 77 borings advanced during the Remedial Investigation (RI) of Lewis Field, only 11 had wet or saturated zones in the overlying soil. These zones were approximately 15 to 76 centimeters (0.5 to 2.5 feet) thick. The zones are thought to be isolated and not to contain significant amounts of groundwater.

The water table generally mimics the surface topography, so groundwater in the unconsolidated zone is expected to discharge to Abram Creek and Rocky River. The groundwater zone within the bedrock is under artesian pressure due to the low hydraulic conductivity of the overlying soils. Even so, the recharge rate is very slow and the shale bedrock has very low permeability (R&R International, 1995). Indications are that the bedrock aquifer can be expected to yield no better than approximately 3.8 liters (1 gallon) per minute.

Only seven permitted drinking water wells are within 6 kilometers (4 miles) of Lewis Field, according to nearby City and Cuyahoga County records (SAIC, 1991). The locations of these wells are unknown. An earlier 1969 survey found 220 individuals in the Rocky River Basin who used groundwater for drinking

water. Groundwater flow from Lewis Field is toward the adjacent creek and river, which precludes it from contaminating water wells in the vicinity.

Groundwater is not used for water supply at Lewis Field. The Phase I RI/FS did not find evidence of groundwater contamination at the Lewis Field site. No aquifer at Lewis Field has been designated as a sole or principal drinking water source under the Safe Drinking Water Act. There are no underground injection wells at the Lewis Field site.

A3.d Wastewater Discharges

Wastewater generated at Lewis Field includes sanitary, stormwater, non-contact and contact cooling, cooling tower blowdown, and miscellaneous process discharges. There are three distinct wastewater collection systems at Lewis Field: the sanitary system, the stormwater system and the Industrial Waste Sewer system. There was once a package sewage treatment plant at Building 415, but it was taken out of service in the 1960's.

The sanitary sewer system receives wastes from lavatories, food preparation areas, and process discharges. A 30 cm (12-inch) gravity sewer line enters the NASA property from the southeast carrying wastes from the nearby I-X (Exposition) Center and portions of the Airport. Near the NASA main gate, the line reaches a pump station and continues as a forced main (Warner/Osborn/Pardee 1990). Advanced tertiary treatment is provided by the Southerly Wastewater Treatment Plant of the North East Ohio Regional Sewer District (NEORSD). Sanitary discharges for the three quarters prior to July 2003 averaged 353,024,654 liters (12,466 MCF). These discharges must meet effluent limitations specified in the NEORSD general sewer use ordinance. Compliance is confirmed through occasional sampling by NEORSD.

Lewis Field has had limited plating, printing, and machining operations. These waste streams have largely been eliminated through process substitution or recycling, or they are being containerized for off-site disposal.

Lewis Field obtains temporary permits from NEORSD for short-term discharges as needed. These are for such things as temporary discharges from construction activities, underground storage tank removal projects, or wastewater from UST cavities. Water quality parameters and monitoring requirements for these permits vary based upon the nature of the discharge.

Stormwater is discharged separately from sanitary wastewater. Stormwater discharges are regulated under the Lewis Field NPDES permit from Ohio EPA, Number OH 3IO00001*FD. The current permit expires June 30, 2007 and requires monitoring at 9 discharge points. Discharge monitoring reports are submitted monthly. The stormwater permit portion of the NPDES permit authorizes discharges from approximately 50 other stormwater outfalls to Abram Creek and Rocky River. Many of the larger outfalls receive stormwater from the Airport, which complicates monitoring and control of these discharges. A summary of Lewis Field NPDES permit requirements is shown in Table A3-1.

The NPDES permit that was issued on December 1, 2002 contained requirements to monitor and report on chlorine in six of the nine outfalls with permitted monitoring requirements. The permit contained an Industrial Dechlorination Schedule that required Lewis Field to submit a plan for compliance with the final chlorine discharge limit of 0.019 mg/l. This plan requires submission to the Ohio EPA by December 1, 2004 with final compliance to the standard by March 1, 2005. During the period of study and compliance preparation, occasional exceedances of the chlorine limit were detected and reported to the Ohio EPA. No additional action from the Ohio EPA occurred.

Table A3-1 Summary of Lewis Field NPDES Permit Requirements

OUTFALL	PARAMETER (UNITS)	DISCHARGE LIMITATION--30-DAY AVERAGE	DISCHARGE LIMITATION--DAILY MAXIMUM	MONITORING FREQUENCY
001	Oil and grease (mg/l)	10	15	1/week
	Flow, total mercury (ng/l)	Monitor only	Monitor only	Mercury 1/month; flow weekly
	Chlorine (mg/l)	- -	0.019	1/month
003, 004, 006, 007, 008	Flow, conductivity	Monitor only	Monitor only	1/week
	Chlorine (mg/l)	- -	0.019	1/week
601, 602, 603	Total suspended solids (mg/l)	10	30	1/week
	Oil and grease (mg/l)	- -	10	1/week
	Total iron (mg/l)	- -	1000	1/week
	Total zinc (mg/l)	320	320	1/week
	Flow, conductivity	Monitor only	Monitor only	1/week
All monitored outfalls	pH (Standard Units)	Not less than 6.5 and not greater than 9.0	Not less than 6.5 and not greater than 9.0	1/week

Facilities which discharge stormwater associated with industrial activity must develop management plans to identify and eliminate sources of stormwater contamination. Lewis Field has prepared a Stormwater Pollution Prevention Plan (Bionetics 1995/SAIC 1999). The implementation of the first phase of the Plan was completed in November 1996. As part of this effort, a map was prepared indicating drainage areas and areas of potential concern regarding stormwater. In October 2001, an amended stormwater application was submitted to Ohio EPA that contained data about changes to Lewis Field as a result of the expansion of the Cleveland Hopkins International Airport. The airport project will ultimately result in portions of Lewis Field property being transferred to the City of Cleveland for runway construction. In addition, there will be a number of Lewis Field facilities that will be relocated. This information, along with the changes in overall acreage, paved and unpaved acreage was part of the amended application. Ohio EPA considered all of this information in the preparation of the combined NPDES/Storm Water permit that was issued on December 1, 2002. Shortly after receipt of the December 1, 2002 permit, Lewis Field was notified by the Ohio EPA that they would now be categorized as a Municipal Separate Storm Sewer System (MS4). Lewis Field was required to submit a Notice of Intent (NOI) and Storm Water Management Plan (SWMP) to Ohio EPA by March 10, 2003, under this new designation. Lewis Field submitted the required documentation to Ohio EPA in February 2003. No new permit requirements have been issued to date.

Based on historical data, NPDES-permitted discharges from Lewis Field appear to have minimal impact on the water quality of the Rocky River. This was confirmed by a study, which found no significant differences in the biological communities upstream and downstream from the Airport (Malcolm Pirnie, 1996). Lewis Field stormwater discharges are bracketed by and often mingled with those from the Airport. Despite this finding, urban runoff and potential flooding problems may have impacted water quality such that additional management practices may become necessary in the future (Warner/Osborn/Pardee, 1990). The Environmental Justice Implementation Plan (Jones, 1996) concluded there was "...no reasonable likelihood of substantial off-site water quality impacts from normal operations

and only moderate likelihood of substantial off-site water quality impacts from emergency operations or reasonably foreseeable accidents ... [and there is] ... no reasonable likelihood of significant impacts to water quality from present or past actions [of solid and hazardous waste programs]."

The Industrial Waste Sewer (IWS) System began operation in 1958 to collect and treat various oily and process wastes from around the Center. The system includes 26 spill containment devices, which trap oil and grease and remove floatables and settleable solids. The IWS is currently used primarily as a central collection system for cooling tower blowdown, wastewater/stormwater from fueling areas, and floor drains, roof drains, and sumps. Current sewer repair projects will eliminate all but cooling tower discharges to the IWS. Although the IWS still receives some wastewater, its main use today is as an oil spill control system and a surge area for cooling towers when they require emptying for maintenance. Flows to the IWS are accumulated in retention basins where further oil removal and settling occurs. The discharge of IWS effluent to the sanitary sewer system was approved in 1992. Since 1994, the basins are discharged only to the sanitary sewer system.

There have been several instances uncovered of inappropriate connections or broken piping which allow wastewater to travel from one system to another, such as from the sanitary system to the storm sewer system. Pollutants may be unintentionally discharged, undetected and untreated. Efforts have been made by the environmental and engineering offices to identify and eliminate these problems. All known problems have been corrected and diagnostic efforts are continuing.

Cooling tower water was once treated with chromium-based biocides. During the 1980's Lewis Field switched to alternative treatment chemicals, which are generally non-toxic. In addition, all cooling tower discharges accumulated in the IWS basins are pumped to sanitary sewers. Non-contact cooling water is generally discharged to the storm sewer system, but only if the chlorine in the water has been removed.

A3.e Water Use and Supply

All water used by Lewis Field is obtained from the City of Cleveland municipal water supply system. The Division of Water draws its raw water supply from Lake Erie through four intakes and serves a total user population of more than 1.5 million people. Three of the four intakes are within 24 kilometers (15 miles) of the Lewis Field site. Lewis Field consumption in FY 2001 was 1.35 billion liters (47,647 MCF).

The majority of water is used for institutional purposes with the balance for research. Institutional water uses include sanitary, food preparation, lawn sprinkling, and hydrant flushing. The most significant research use of water is for cooling, especially for the wind tunnels. There are four large cooling systems with a combined capacity of 15.2 million liters (535 MCF). Efforts have been made to conserve water such as converting once-through cooling systems to closed-loop or recirculating systems and repairing cracked or broken pipes. Since 1992, major repair work has been performed on the Lewis Field Central Water Distribution System, which necessitated extensive flushing of the water mains and associated hydrants. All drinking water fountains on-site are tested for contaminants and free chlorine content at least once every two years.

Lewis Field does not store potable water on-site for drinking water purposes.

A4 LAND RESOURCES

A4.a Topography

The topography near Lewis Field consists of gently rolling uplands created by glacial outwash. Lewis Field itself is generally level due to extensive cut-and-fill operations that reclaimed much of the area from steep drainage swales that once crossed the site. These drainage features were filled in with a variety of undifferentiated soils and gravels, construction debris, and industrial and domestic waste (Figure A4-1). This overall topography contrasts sharply with the deeply eroded valleys and sloping banks of Abram Creek and Rocky River. These ravines are 15 to 30 meters (50 to 100 feet) deep, with an estimated maximum sidewall slope of 75 degrees.

The Central Area and most of the site is between 229 to 235 meters (750 and 770 feet) above sea level. Elevations in the South Area are similar to those in the Central Area but drop sharply to about 201 meters (660 feet) at Abram Creek. The West Area is relatively flat and its natural relief has been generally undisturbed by earth fill or removal. The northern edge of the North Area is wooded, and the Rocky River traverses its northwest boundary. Most of this area is flat with the natural contour only slightly changed by the construction of buildings.

A4.b Geology and Soils

During the Pleistocene Epoch, northern Ohio was modified by the Nebraskan, Kansan, Illinoian, and Wisconsian continental glaciation events. Advancing and retreating ice fronts deposited till and glacial outwash over much of northern Ohio. As the Wisconsian ice front advanced and retreated across northern Ohio, it occupied several positions within the Lake Erie basin and acted as a temporary dam (SAIC, 1991). These ice dams formed several different lakes including what is now known as Lake Erie.

Cleveland is located on the western flank of the undeformed portion of the Appalachian Basin, which extends northeastward from Alabama across portions of Tennessee, Kentucky, Virginia, West Virginia, Ohio, Pennsylvania, and New York. The basin contains a southeastward-thickening prism of sandstones, carbonates, shales, and salts that aggregate to a thickness of 1,981 to 7,010 meters (6,500 to 23,000 feet). Sedimentation in the basin occurred throughout the Paleozoic Era (600 to 246 million years ago) and culminated at the end of the last Appalachian Orogeny (White, 1984 as cited in SAIC, 1991).

Bedrock in the immediate vicinity of Lewis Field is composed of the Cleveland Shale Member of the Ohio Shale (Ebasco, 1989). The Cleveland Shale Member is dark gray to black, thin bedded, and weathers to thin slatey fragments that are stained brown. This is exposed in the bed and valley walls of the tributaries to Abram Creek, Abram Creek itself, and Rocky River.

In northwestern Cuyahoga County, the surface is primarily covered by a thin layer (several inches to a few feet) of lacustrine clay and silt deposits that are underlain by Wisconsian aged glacial tills (White, 1984 as cited in SAIC, 1991). Naturally occurring soils include the Mahoning Association, the Brecksville silt loam, the Chagrin silt loam, and the Jimtown loam. The Brecksville silt loam is found in the stream valley of Abram Creek, the Chagrin silt loam in the flood plain of Abram Creek, and the Jimtown loam in the West Area. The parent materials of these soils consist of unconsolidated Lavery glacial till and alluvium. The Lavery Till is primarily silty-sandy to silty clayey and is transected by closely spaced joints which are steeply inclined to near vertical. The Lavery Till overlies bedrock or unnamed deposits of sand and silt, which range in thickness from 0.3 to 3.4 meters (1 to 11 feet) (Ford, 1987). Soils of the Mahoning Association cover most of the Central Area. These soils generally have low to very low permeability and are classified as a silty clay loam, although they often grade to a clay loam glacial till. The natural soils and parent materials in many cases have been removed or covered with fill. Geology in the area is illustrated in Figure A4-2.

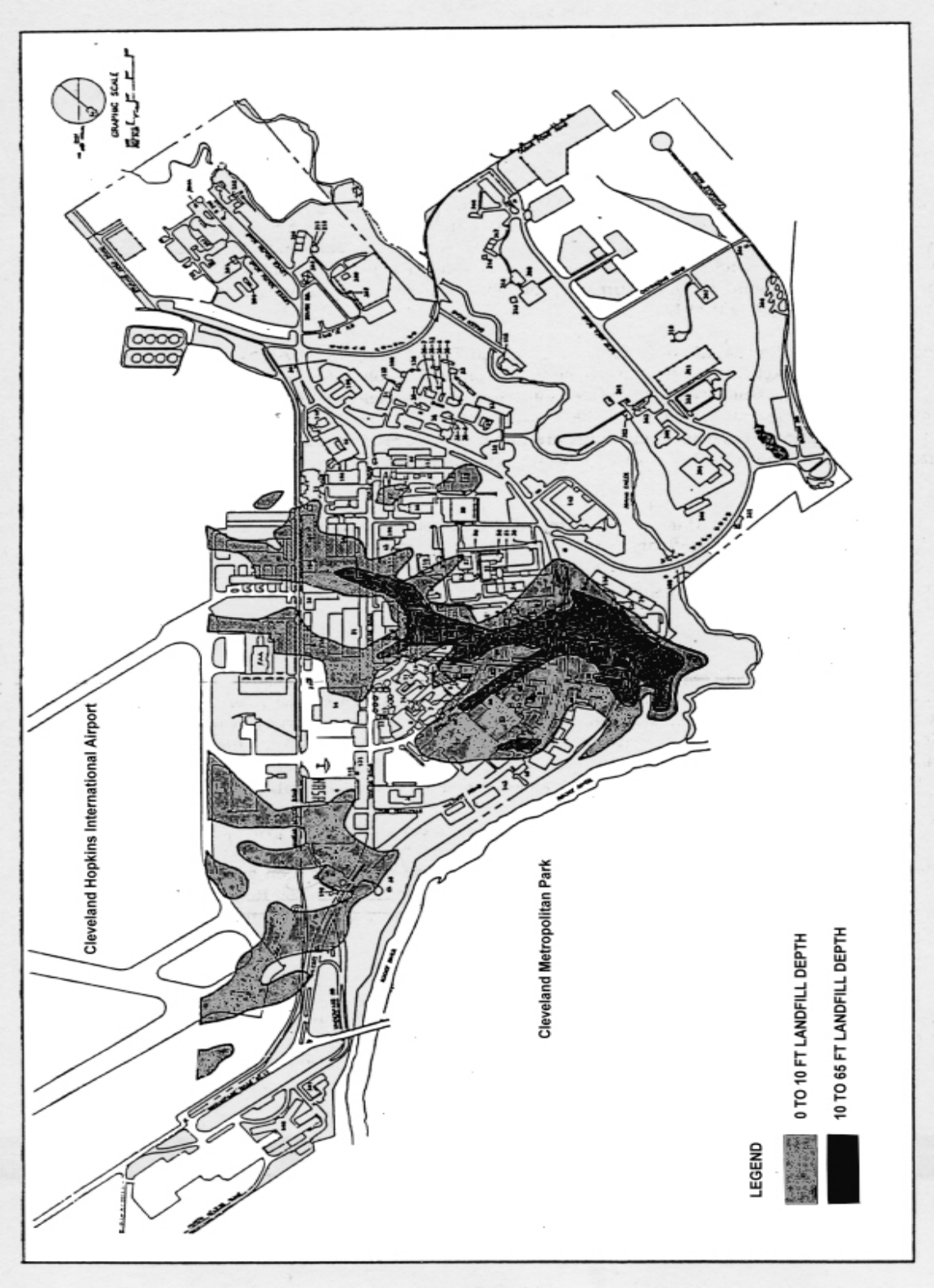


Figure A4-1 Locations of Fill in Central Area at Lewis Field

Source: SAIC, 1993 Lewis Research Center Site Inspection Work Plan.

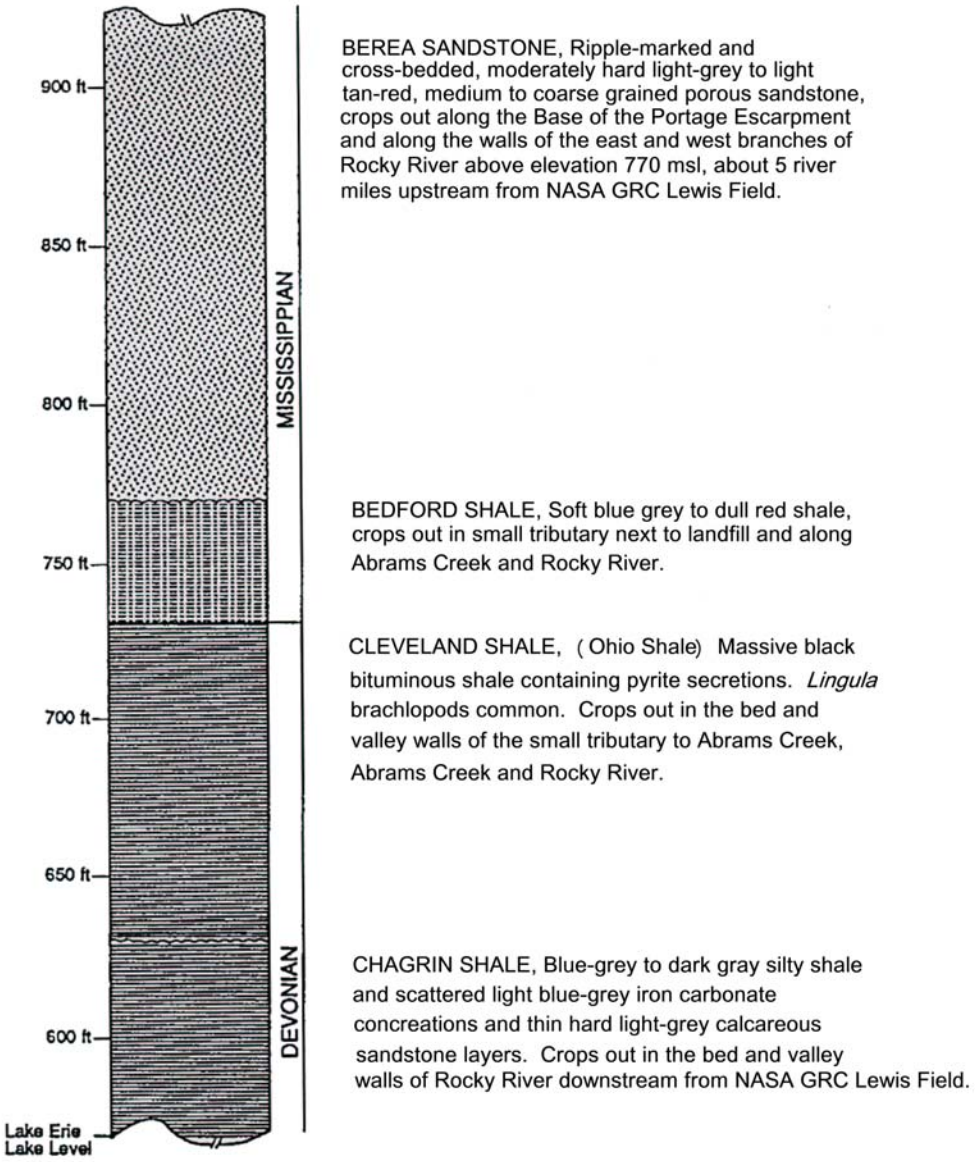


Figure A4-2 Generalized Geology of Lewis Field

Figure A4-2 Generalized Geology of Lewis Field

Source: SAIC, 1991 Preliminary Assessment for the NASA Lewis Research Center.

A4.c Seismology

The State of Ohio, including Lewis Field and PBS, is located in Seismic Zone 1 (Ohio Building Code, 1990). The probability of an earthquake causing structural damage is minimal. The Ohio Shale is fissile, however, and offers differential resistance to applied stresses depending upon the inclination to the direction of stratification.

A4.d Surface Water Hydrology

The primary surface water features at the Lewis Field site are the Rocky River and its tributary, Abram Creek (see Figure A1-1). The Rocky River flows along the western edge of the Lewis Field site, separating it from the Rocky River Reservation of the Cleveland Metropolitan Park District. The Ohio EPA lists the drainage area of the Rocky River at 761 square kilometers (294 square miles). The Rocky River is a third-order stream with an average daily discharge rate of 7.8 cubic meters (276 cubic feet) per second, as measured at a USGS gaging station 2.6 kilometers (1.6 miles) upstream from Lewis Field. The 7-day, 10-year low flow is estimated by the USGS to be 0.04 cubic meters (1.4 cubic feet) per second. Wastewater discharges and removals within the basin are significant and result in an effective 7-day, 10-year low flow of 0.87 cubic meters (30.6 cubic feet) per second. After passing Lewis Field, the river flows north approximately 18 kilometers (11 miles) and discharges into Lake Erie.

Most surface water runoff from Lewis Field flows through the storm sewer system and natural swales to Abram Creek and Rocky River. Although most precipitation is believed to flow overland, several low-volume seeps have been observed on the Abram Creek Valley walls after periods of heavy rainfall (SAIC, July 1993).

Additional information regarding drainage patterns at Lewis Field can be found in Section A3.

A4.e Coastal Zone Management Issues

Ohio has developed a Coastal Zone Management Plan, which has received Federal approval. Lewis Field is not located in the Ohio coastal zone.

A4.f Prime and Unique Farmlands

Land within Lewis Field is exempt from considerations of the Farmland Protection Policy Act (FPPA) because the land was purchased before August 6, 1984, for the purpose of redevelopment. In other words, land is not considered prime farmland if it has been committed to urban development (i.e., commercial, industrial, or residential).

A4.g Land Acquisition and Land Use

The Glenn Research Center owns or leases 147.62 hectares (364.49 acres) of land at Lewis Field. The original property was acquired in 1940 and measured approximately 81 hectares (200 acres). The land had been owned by the City of Cleveland as part of an expansive airport property and used at the time to provide parking and spectator areas for the National Air Races held at the municipal airport. The West Area was acquired between 1958 and 1962, bringing the site close to its current size.

Most of the Lewis Field site, particularly in the Central Area, is considered fully developed with offices, test facilities, and support facilities. All site structures must conform to FAA restrictions due to proximity to the Airport. Only approximately 69 hectares (170 acres) are considered undeveloped. The recreational facilities in the West Area provide some open space.

The United States Government owns most of the land outright. Some 5.3 hectares (13 acres) in the North Area are leased from the City of Cleveland for use as a parking lot. A portion of this lot is in an area where the Airport is creating a "clear zone" at the end of one of the runways. While this use was once acceptable, the FAA now believes that parking lots in clear zones represent a hazard to aircraft safety and should be removed. Accordingly, the City has not permanently renewed the lease and is currently extending it on a short-term basis.

The City of Cleveland is expanding the Hopkins International Airport. This requires the use of portions of the NASA South Area for additional and extended runways. This tract now includes the Rocket Engine Test Facility (Building 202), the Cryogenic Components Laboratory (Building 203), the High-Load Tensile Test Facility (Building 204), the Central Chemical Storage Facility (Building 212), and other structures, which will have to be removed. The City has begun relocating NASA's affected facilities to suitable alternative locations.

NASA is negotiating with the City of Cleveland to acquire two parcels of land adjacent to Cedar Point Road. These parcels are designated Parcels A and B. NASA is also negotiating to acquire a ten-acre lot currently used as the North Area parking lot. The City of Cleveland is negotiating with NASA to acquire a lot adjacent to Cedar Point Road, which is situated within the Airport's perimeter fence. This lot is designated as Parcel C. NASA completed a Phase I Property Transfer Site Assessment of each of these parcels and did not discover negative conditions associated with the parking lot and parcels.

In addition to the Airport, the surrounding area contains several industrial complexes, business districts, highways, and a residential area of moderate density (two to six dwellings per acre). The area is highly urbanized and developed. Strict safety precautions are maintained to protect the public health and safety. Lewis Field is also adjacent to a large recreational park, the Rocky River Reservation. This is a protected environment and includes the entire course of the Rocky River from Lewis Field to Lake Erie.

A4.h Current Policies and Procedures for Landscaping Management

A 1994 White House Memorandum on *Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds* encourages the use of techniques that complement and enhance the local environment and minimize any adverse effects of landscaping. The Memorandum directs Federal agencies to use regionally native plants for landscaping, minimize adverse effects on natural habitats, conserve water in landscaping, and prevent pollution through such techniques as reducing the need for fertilizer and pesticides, minimizing runoff, using integrated pest management, and recycling.

Lewis Field adheres to this Memorandum as well as the recommendations of the *Protected Species Management Strategy for NASA Glenn Research Center and NASA Plum Brook Station* (SAIC, 2002). The plan recommends that the planting and propagation of alien species be minimized. The EMO supplies the GRC community with lists of approved species as needed. Since 1997 certain lawn areas at Lewis Field were allowed to revert to grass meadows to provide additional habitat for wildlife.

GRC is developing a Life Cycle Analysis tool to be used in the design phase of projects, which includes considering cradle-to-grave environmental impacts on land, air, and water, and biological / biodiversity issues.

All planned construction projects at Lewis Field are reviewed for environmental impacts, which include adverse effects on the natural habitat and pollution prevention (P2) initiatives. A construction erosion control procedure is currently being developed.

Sustainable Design (SD) is a large construction/architecture concept, also incorporating Life Cycle Analysis. SD is a tool, which will be developed by NASA's Kennedy Space Center, the P2 Lead Center.

It is a goal of GRC to exercise integrated pest management practices whenever pest control is necessary. GRC stores, applies, transports, and disposes of pest control materials according to all applicable Federal, State, and local statutes. It is a goal of GRC to minimize the storage, use, and disposal of pesticides onsite. Pesticide use at GRC is exercised with a goal of minimizing both human exposure and adverse environmental impacts.

Affirmative Procurement/Environmentally Preferable Purchasing (AP/EPP) lists are being compiled, using Life Cycle concepts to rate commercial products. AP/EPP incorporates efficient water use as a rating criterion when evaluating products.

Landscaping and GRC infrastructure jobs (such as plumbing practices) will be reviewed in the future as a part of AP/EPP, Life Cycle, Sustainable Design, and/or P2.

A5 BIOTIC RESOURCES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to biotic resources. Relevant chapters include:

- Chapter 19 Endangered and Threatened Species

A5.a Environmental Setting

Lewis Field is situated in a highly urbanized area of western Cuyahoga County, approximately five miles south of Lake Erie. Cleveland Hopkins International Airport borders the facility to the east. This massive facility prevents the migration or dispersal of many species into Lewis Field. To the west and north of Lewis Field lies the Cleveland Metroparks Rocky River Reservation (http://www.clemetparks.com/). The reservation encompasses 1,389 hectares (3,432 acres) adjacent to a warmwater habitat river. The park offers significant opportunities for the migration or dispersal of many species into Lewis Field. Residential neighborhoods or parking lots border Lewis Field along the remaining property line.

A5.b Flora

Much of the following information in this chapter was taken from *Protected Species Management Strategy for NASA Glenn Research Center* (SAIC, 2002) and *Biological Inventory of the NASA Lewis Research Center* (ODNR, 1996). The *Protected Species Management Strategy for NASA Glenn Research Center*, complete with graphics, is posted on the web at http://osat-ext.grc.nasa.gov/emo/pub/psm-index.htm

The composition of the original vegetation at the Lewis Field site is unknown. Lewis Field lies in the Beech-Maple Forest region of the great eastern Deciduous Forest of Eastern North America. This region has been classified as a mixture of Beech Forest, Mixed Oak Forest, Elm-Ash Swamp Forest, and Mixed Mesophytic Forest. At Lewis Field, the uplands were most likely dominated by a mixture of Beech-Maple and Elm-Ash forests depending on local soil types and hydrology. The Abram Creek gorge provides a microclimate for more northern species and would be classified as a southern pocket of Hemlock-White Pine-Northern Hardwood Forest (Braun, 1961). Mixed Mesophytic Forest likely was present on the slopes of the gorge. The terrace of Abram Creek is too narrow to support swamp forests or riverine woodlands. The original forest cover was removed during the early 1800's, destroying the natural vegetation. The denuded uplands likely were cultivated and/or grazed and subsequent continuing development has prevented the land from reverting to a natural state. Fire was not a major factor affecting the composition of plant communities at Lewis Field.

Most of the site is now too highly disturbed to support significant numbers of indigenous Ohio plant species. Approximately 69 hectares (170 acres) at Lewis Field are considered undeveloped. The gorge of Abram Creek and the tops of the bluffs above the valley are the only areas that retain natural qualities. These areas contain forest communities similar to their original types.

The ODNR, Division of Natural Areas and Preserves (DNAP) conducted a botanical survey Lewis Field in 1995 (ODNR, 1996). During that survey, 159 species of vascular plants were cataloged, of which three were listed by the Division as Ohio rare species.

SAIC and the Division of Natural Areas and Preserves were requested by the Environmental Management Office to undertake a follow up botanical survey in 2001. The goals of the 2001 survey were to update the vascular plant catalogue and to identify any new listed species. In 2001, 147 of the species found in 1995 were relocated and 8 new additions to the catalogue were made. The species surveys complement

the plant community survey and geographic information system (GIS) development that occurred concurrently with the species surveys.

Plant communities were classified according to the Federal Geographic Data Committee (FGDC) Vegetation Classification Standard (FGDC, 1997). This classification system includes a hierarchy of five physiognomic (e.g., dominant plant type such as herb, shrub, or tree as well as observed hydrology) levels and two floristic levels, and is the approved standard for vegetation classification on federal lands.

The association is the most basic unit of vegetation. It is a recurring plant community of characteristic composition and structure. The alliance is defined as follows: A grouping of associations with a characteristic physiognomy and habitat and which share one or more diagnostic species that, as a rule, are found in the uppermost or dominant stratum of the vegetation. Formation is a level in the classification based on ecological groupings of vegetation units with broadly defined environmental and additional physiognomic factors in common. (FGDC, 1997)

For example, a unit of vegetation could be described as follows:

Table A5-1
Physiognomic Categories Used in the Biological Survey

PHYSIOGNOMIC CATEGORIES	
CATEGORY	**EXAMPLE**
Class	Open Tree Canopy
Subclass	Evergreen Open Tree Canopy
Group	Temperate or Subpolar Needle-leaved Evergreen Open Tree Canopy
Subgroup	Natural/Semi-natural
Formation	Rounded-crowned temperate or subpolar needle-leaved Evergreen Open Tree Canopy
FLORISTIC CATEGORIES	
Alliance	Juniperus occidentalis Woodland Alliance
Association	Juniperus occidentalis/Artemesia tridentate Association

Eleven formations and six alliances were identified at Lewis Field in 2001 and are listed below. Descriptions of the the six alliances can be found in the *Protected Species Management Strategy for NASA Glenn Research Center*, Volume II, Appendix C. Their locations are delineated on a map, *Plant Communities at Lewis Field*, which is accessible on the internal web at http://osat-ext.grc.nasa.gov/emo/pub/PSMS/Volume%20I/A1-2/A2-LewisPlntsMapClr2.pdf.

- Formation: I.A.8.N.c. Conical-crowned temperate or subpolar needle-leaved evergreen forest
- Formation: I.C.3.N.a. Mixed needle-leaved evergreen - cold-deciduous forest
  Tsuga canadensis - Betula alleghaniensis Forest Alliance (MFU1)
- Formation: I.B.2.N.a. Lowland or submontane cold-deciduous forest
  Fagus grandifolia - Acer saccharum - (Liriodendron tulipifera) Forest Alliance (FU1)
  Quercus rubra – Acer saccharum – (Quercus alba) Forest Alliance (FU3)
- Formation: I.B.2.N.e. Seasonally flooded cold-deciduous forest
  Acer rubrum - Fraxinus pennsylvanica Seasonally Flooded Forest Alliance (FL3)
- Formation: III.B.2.N.a. Temperate cold-deciduous shrubland

- Formation: V.A.5.C.b. Landscaped urban/suburban/rural (residential yards, nurseries)
- Formation: V.A.5.N.c. Medium-tall sod temperate or subpolar grassland
- Formation: V.A.5.N.l. Semipermanently flooded temperate or subpolar grassland
  Typha (*angustifolia*, *latifolia*) - (*Scirpus* spp.) Semipermanently Flooded Herbaceous Alliance (HL4)
- Formation: V.B.2.N.a. Tall temperate or subpolar perennial forb vegetation
- Formation: V.B.2.N.c. Intermittently flooded temperate perennial forb vegetation
- Formation: V.C.2.N.a. Permanently flooded temperate or subpolar hydromorphic rooted vegetation
  Potamogeton spp. - *Ceratophyllum* spp. - *Elodea* spp. Permanently Flooded Herbaceous Alliance (HL6)

The results of this survey demonstrate that the extensive development of GRC as a research facility has limited the extent and recovery of natural plant communities. These communities contain few rare species. The Abram Creek gorge and adjacent blufftops contain the most significant natural plant communities. The plant communities shown on the map *Plant Communities at Lewis F*ield (see website) were identified during the plant community survey, and are described in Volume II of the *Protected Species Management Strategy*. The plant community descriptions provided in the *Protected Species Management Strategy* are based partly on the alliance summaries developed for Ohio by The Nature Conservancy in 1997.

A5.c Fauna

Animals censused at Lewis Field during the 2001 ODNR surveys included birds, amphibians, reptiles, lepidoptera, and bats.

The 2001 breeding bird survey found species common in urban/suburban/open areas in this part of Ohio. Seventy species of birds were identified at Lewis Field. Species found most often included the European starling, house sparrow, American robin, chimney swift, and house finch, which together accounted for more than half of all sightings. The "wooded, successional, and grassland habitats" in this area were judged to be too small and fragmented to support other species.

The 2001 reptile and amphibian survey revealed three common amphibians and one reptile, a snapping turtle, at Lewis Field. All finds were located in the water bodies at either the Guerin House, the coal pile retention basin, or the industrial waste basins.

Fish were surveyed only at PBS. Previous investigations (Environment and Archaeology, 1999 and Ohio EPA, 1999) of fish in Abram Creek have not identified significant populations of any fish species. The creek receives runoff containing de-icing compounds from the Cleveland Hopkins International Airport. This contamination appears to severely limit fish populations; therefore, it was determined that additional investigation of fish would be of no benefit during the 2001 survey.

A lepidoptera (butterfly and moth) survey was conducted at Lewis Field in 2001. As a result of this survey, 17 species of butterflies were recorded. A total of 112 species of moths were recorded. No significant species were discovered.

A maximum total of eight bat encounters occurred in August 2002 during the bat survey (some of which may have been the same individuals). The bat population at Lewis Field is sparse. Three common bat species were identified during the survey. There was no evidence of the federally endangered Indiana bat.

Although not surveyed, mammals on the Lewis Field site likely include squirrels, chipmunks, rabbits, deer, and groundhogs common to urban neighborhoods.

A5.d Unique and Important Habitats

Areas at Lewis Field recommended for special attention include the wooded area behind Building 309 where there are large oaks and other trees (*Endangered Species Management Plan*, Bionetics, 1996). ODNR recommended that conservation strategies here include not altering the ground surface to protect tree roots, and to eliminate mowing, using herbicides, or introducing non-native vascular species under the trees. Other areas identified for protection include the wooded riparian corridor along Abram Creek and the grassy fields in the West Area. Recommendations were to not disturb these areas and to not mow the grassy fields until late summer to preserve potential bird habitat.

The Plan also recommends that the planting and propagation of alien species be minimized. The EMO currently provides the GRC Lewis community with lists of approved species as needed. Another suggestion was to allow some lawn areas to revert to grass meadows to provide additional habitat for wildlife. To implement this recommendation and in keeping with the White House Memorandum on Environmentally Beneficial Landscaping, 10.5 hectares (26 acres) in the West Area have been converted from lawns to an un-maintained, meadow-type habitat beginning in 1997.

Lewis Field has adhered to the *Endangered Species Management Plan*, Federal and state regulations regarding management of biological resources. It is the intent of Lewis Field management to revise the *Endangered Species Management Plan* to incorporate the recommendations of the *Protected Species Management Strategy*.

A6 ENDANGERED SPECIES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to endangered species. Relevant chapters include:

- Chapter 19 Endangered and Threatened Species

A6.a Listed Species

Much of the information in this chapter was taken from *Protected Species Management Strategy* for NASA Glenn Research Center (SAIC, 2002) and *Biological Inventory of the NASA Lewis Research Center* (ODNR, 1996).

Only two known Ohio-listed species, pigeon grape (*Vitis cinerea*) and American chestnut (*Castanea dentata*), are located at Lewis Field (Table A6-1, Figure A6-1). The American chestnut parent tree died during the winter of 2002. Chestnut suckers have sprouted from the base of this tree. A brief description of these species, their ranges, habitats, life history and ecology, unique characteristics can be found at http://www.ohiodnr.com/dnap/heritage/Rare_Species2002.htm.

The black-throated green warbler was the only species of concern discovered in 2001. It was an isolated individual, unlikely to be nesting at Lewis Field.

Lewis Field has no known direct adverse effects on endangered species beyond its borders.

Table A6-1
Listed Species at Lewis Field

Species Name	Status
Vitis cinerea	Ohio potentially threatened
Castanea dentata	Ohio potentially threatened

A6.a Endangered Species Management

In general, the primary management recommendation for these plant species was to maintain the plant communities within Abram Creek gorge and the adjacent blufftops as discussed in Section 6, Volume III of the Protected Species Management Strategy (ODNR 2002). Non-native species should not be planted anywhere at Lewis Field, especially near or within natural areas. The vines of the pigeon grape (*V. cinerea*) should remain undisturbed on the east side of the Abram Creek gorge. No specific management is recommended for the American chestnut (*C. dentata*).

The black-throated green warbler was the only species of concern discovered. There were no specific management recommendations in the Management Plan to address this species.

Based on the 1995 ODNR survey, the Environmental Management Office prepared an *Endangered Species Management Plan* (Bionetics, 1996). The Plan recommends management practices, which were implemented. Areas, which contain the listed species, are posted with signs indicating that threatened species are present. Any use of pesticides or herbicides in these areas must be approved by the EMO. The EMO monitors the areas twice each year to assess the status of the target species. Photographs and inspection logs are maintained for documentation. Any declining trends in population will be brought to the attention of the ODNR for consultation to determine what actions can be taken to facilitate recovery.

The EMO will continue to manage the protected species at Lewis Field. The EMO will follow the management recommendations of Volume III of the Protected Species Management Strategy and adhere to the practices described in the Lewis Field *Endangered Species Management Plan.*

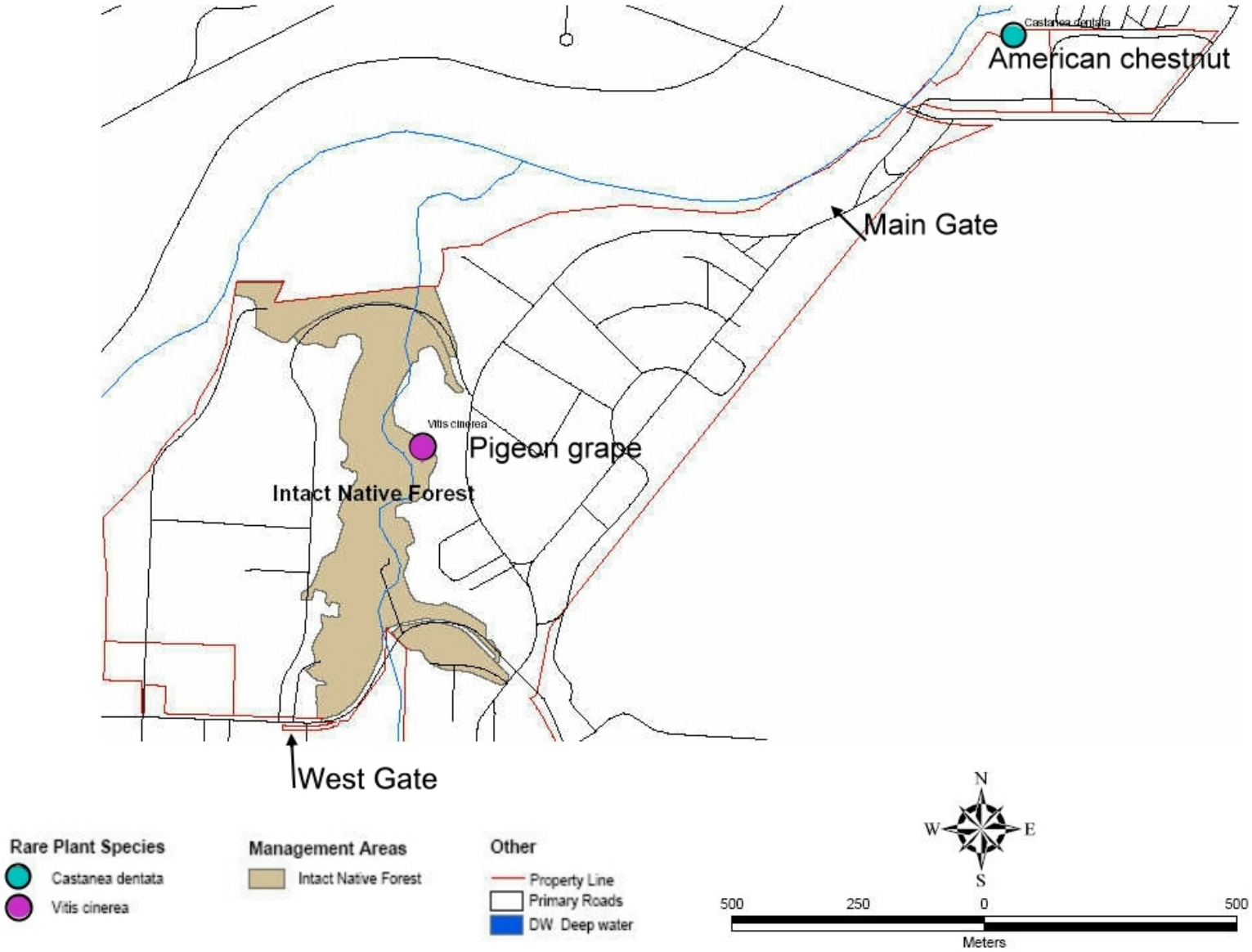


Figure A6-1 Native Forest and Locations of Potentially Threatened Species at Lewis Field

A7 WETLANDS AND FLOODPLAINS

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to floodplain and wetlands. Relevant chapters include:

- Chapter 18 Floodplain and Wetlands Management

A7.a Floodplains

According to Flood Insurance Rate Maps (FIRMs), published by the Federal Emergency Management Agency (FEMA), floodplains at Lewis Field occur in narrow strips of lowland parallel to Abram Creek (Figure A7-1). Abram Creek fulfills the criteria for an area of special flood hazard (the Special Flood Hazard Area, which is defined as an area of land that would be inundated by a flood having a 1% chance of occurring in any given year). No other mapped floodplains occur on Lewis Field property. Copies of the Flood Insurance Rate Maps for Lewis Field are maintained by the GRC EMO Environmental Compliance Team.

The 500-year floodplain for Lewis Field has not been mapped.

The expansion of Cleveland Hopkins International Airport requires the removal and relocation of several NASA research facilities located in the South 40 Area (see Figure A1-1). The 100-year floodplain for Lewis Field has been mapped by the Army Corps of Engineers. The Lewis Field relocation sites for the South 40 facilities are located above the predicted 100-year floodplain of the Abram Creek.

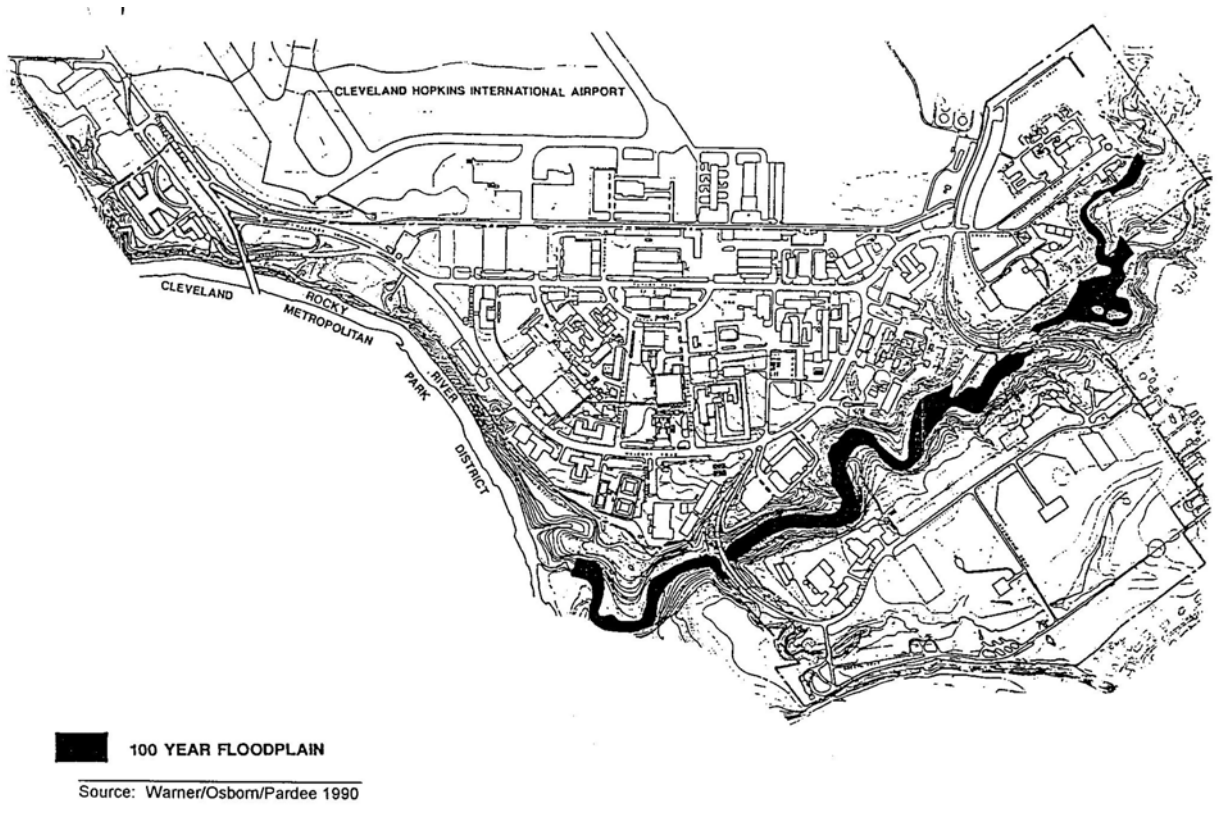


Figure A7-1 Lewis Field 100-Year Floodplain

One facility at Lewis Field had been in the Abram Creek floodplain, the Firing Range. The Firing Range was taken out of service in the early 1990's. It is targeted for remedial action under CERCLA. No date has been set for the remediation.

No Lewis Field facilities remain in the 100-year floodplain. There are no activities currently located in floodplains at Lewis Field. It is GRC policy to restore, preserve, and protect the natural and beneficial values provided by floodplains. In carrying out this policy, GRC avoids adverse impacts associated with the occupancy and modification of floodplains.

A7.b Wetlands

For regulatory purposes, wetlands must have all of the following three attributes:

1. At least periodically, the land supports plants adapted to grow in water.
2. The substrate is predominantly undrained soil having or characterized by excessive moisture.
3. The substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

Wetlands at Lewis Field have not been officially delineated. Accurate interpretations of jurisdictional status require site-specific field delineation. Until an official delineation occurs, Lewis Field must rely on studies, which indicate the potential or probable locations of wetlands at Lewis Field. Copies of the wetland indicator maps for GRC are maintained by the Environmental Compliance Team. Reference can be made to the *Final Protected Species Management Strategy For NASA Glenn Research Center At Lewis Field And Plum Brook Station, Volume II: Plant Community Survey* (SAIC, 2002) for the probable locations of wetlands at Lewis Field.

Four areas at Lewis Field were identified during the 2002 survey as probable wetlands. They were:

1. Formation: I.B.2.N.e. Seasonally flooded cold-deciduous forest

Acer rubrum - Fraxinus pennsylvanica Seasonally Flooded Forest Alliance (FL3)

This forest alliance contains a mixture of upland, mesic species in combination with hydrophytic species. It is located in areas subject to seasonal flooding and is often located along streams. At Lewis Field, it occurs in a narrow band along a small drainage ditch in the western part of the facility behind Building 333.

2. Formation: V.A.5.N.l. Semi-permanently flooded temperate or subpolar grassland

Typha (angustifolia, latifolia) - (Scirpus spp.) Semipermanently Flooded Herbaceous Alliance (HL4)

The cattail marsh alliance occurs along pond edges, roadside ditches, and shallow basins and is very common throughout the United States. A single example of this alliance is located around the perimeter of the coal-pile runoff pond in the South 40 Area.

3. Formation: V.B.2.N.c. Intermittently flooded temperate perennial forb vegetation

Intermittently flooded early successional herbaceous field (HL1)

Species composition of this community is very similar to the Dry early-successional herbaceous field community. However, this community is characterized by the additional presence of species found in wet environments such as sedges (*Carex* spp.) and rushes (*Juncus* spp.) as well as invasive, mesic plants such as garlic mustard (*Alliaria petiolata*). These hydrophytic species generally are found in patches in low areas and do not dominate the community. One example of this community is located in the firing range area adjacent to Abram Creek.

4. Formation: V.C.2.N.a. Permanently flooded temperate or subpolar hydromorphic rooted vegetation

Potamogeton spp. - *Ceratophyllum* spp. - *Elodea* spp. Permanently Flooded Herbaceous Alliance (HL6)

This alliance occurs in shallow open water areas generally less than 2 m (6.6 feet) deep. TNC (1997) defines this alliance as having up to 25% cover by emergents or floating-leaved aquatics and at least 25% submerged aquatics. Pondweeds (*Potamogeton* spp.), hornworts (*Ceratophyllum* spp.) and waterweed species (*Elodea* spp.) dominate the community. The shallow pond north of Building 333, between Guerin and West Area Roads, contains vegetation that corresponds to this alliance.

Additional guidance is found in the publication *Soil Survey of Cuyahoga County,* (USDA, Natural Resources Conservation Service, 1980) which is also maintained by the Environmental Compliance Team.

The ECT also maintains a copy of the Wetlands Inventory Map of the Lakewood, Ohio quadrangle (USFWS, 1977), which encompasses Lewis Field. This map is also an indicator of wetlands, not a delineation.

In 1998, Environment and Archeology, Limited Liability Company, a contractor supporting the Cleveland Hopkins International Airport expansion, surveyed eight areas at Lewis Field for the presence of wetlands. A resulting publication, *Wetland Survey Report for the NASA Glenn Research Center at Lewis Field Cleveland, Ohio* (Parsons Corporation, 2000) concluded that selected sites at Lewis Field did not exhibit any indications of wetland hydrology, hydric soils, or a dominance of wetland vegetation to warrant a Section 404 Permit. A copy of this report is on file with the ECT.

There are no activities currently located in wetlands at Lewis Field. It is GRC policy to restore, preserve, and protect the natural and beneficial values provided by wetlands. In carrying out this policy, GRC avoids adverse impacts associated with the occupancy and modification of wetlands.

Lewis Field is not engaged in a wetlands banking program.

A8 SOLID WASTE GENERATION, TREATMENT, STORAGE AND DISPOSAL

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to solid waste generation, treatment, storage, and disposal. Relevant chapters include:

- Chapter 5 Management Of Hazardous Materials And Waste For Reuse, Recycling, Or Disposal
- Chapter 6 Pollution Prevention and Greening the Government
- Chapter 9 Asbestos
- Chapter 17 Solid Waste
- Chapter 33 Bloodborne Pathogens (e.g., medical waste)
- Chapter 34 Handling and Disposal of Soil

A8.a Current and Projected Waste Streams

The Annual Waste Disposal inventory for calendar year 2002 and projected waste volumes for CY 2003 follows.

Table A8-1 Solid/Hazardous Waste Generation at Lewis Field*

MATERIAL DISPOSED	Annual - 2002		Projected - 2003	
	Metric	English	Metric	English
Non-hazardous Waste				
ACM (TSCA)	539 kg	1,254 lb	579 kg	1,347 lb
Lab Pack Material	1,724 kg	3,800 lb	1,851 kg	4,081 lb
PCB (TSCA)	8,551 kg	18,852 lb	9,183 kg	20,245 lb
Petroleum Product	99,828 l	21,959 gal	107,205 l	23,582 gal
Soil, Non-Hazardous	26,026 m^3	34,040 yd^3	28,949 m^3	36,556 yd^3
Clean-hard fill	92 m^3	120 yd^3	99 m^3	129 yd^3
Recyclable Material	655 kg	1,443 lb	703 kg	1,550 lb
Spill Response	643 kg	1,418 lb	691 kg	1,523 lb
Remedial Activity	29,310 kg	64,617 lb	31,476 kg	69,392 lb
Solid Waste	580 t	639 tn	622 t	686 tn
Recyclable Solid Waste	449 t	495 tn	482 t	532 tn
Other	940 kg	2,073 lb	1,010 kg	2,226 lb
Hazardous Waste				
Lab Pack Material	15,513 kg	34,199 lb	16,659 kg	36,726 lb
Soil, Hazardous	275 m^3	360 yd^3	296 m^3	387 yd^3
Spent Solvents	2,884 kg	6,357 lb	3,097 kg	6,827 lb
Recyclable Material	5,892 kg	12,989 lb	6,327 kg	13,949 lb
Lead Abatement Debris	48,500 kg	106,923 lb	52,084 kg	114,825 lb
Spill Response	643 kg	1,418 lb	691 kg	1,523 lb
Remedial Activity	9,770 kg	21,539 lb	10,492 kg	23,131 lb
Other	313 kg	691 lb	337 kg	742 lb

*Waste generated and tracked for CY2002; all wastes generated have been characterized per RCRA Solid Waste requirements. Hazardous and non-hazardous soils have been characterized and have been determined to be either RCRA regulated solid wastes or commercial/industrial fill as determined by CERCLA Voluntary Action Program (VAP) standards. Solid waste is defined as paper, cardboard, tin cans, metal glass, rubber, plastic, landscaping brush, wood, garbage and other miscellaneous debris.

A8.b Hazardous and Toxic Waste Management

Generators of hazardous material or waste are responsible for properly identifying and labeling waste as to its contents and potential hazard. The GRC EMO Waste Management Team (WMT) is available to assist in the identification and labeling of materials and wastes to be turned in. The generator prepares a NASA form C-260a, "Waste Disposal Request", and submits it to the WMT for determination of proper disposal.

Alternatively, the GRC Logistics and Technical Information Division (LTID) Property Disposal may receive a Glenn Property Disposal Turn-in Document, NASA form C-260 for waste which has the potential to be contaminated. LTID, as required, forwards the NASA C-260 either to the WMT or the ECT to determine the ultimate disposition of materials or equipment that may contain a hazardous material or waste.

The ECT provides technical input to the Property Disposal Officer via the form C-260 for managing hazardous materials and disposing of equipment containing hazardous material. It provides technical direction, methodology, and consultation to any user for turn in of hazardous materials, equipment containing hazardous material, and soils containing hazardous materials. ECT can provide analytical chemistry support for identifying unknown materials prior to turn in for disposal. It assures that hazardous waste disposal contractors under contract to GRC conduct their activities at a licensed/permitted waste disposal facility. The ECT also maintains responsibility for signing all hazardous waste manifests and investigates and inquires, as necessary, regarding shipments prior to signing the manifests. It performs at least one compliance audit per year on the Hazardous Waste Management function and provides an audit report to the Chief of the EMO. EMO issues orders to address audit deficiencies is responsible for educating personnel on hazardous material and hazardous waste handling and waste reduction.

The WMT manages and implements a program for managing hazardous materials and disposing of hazardous wastes. It provides documentation to the Property Disposal Officer of records of shipment for disposal of hazardous wastes and materials. It recommends to and educates the user in the proper procedures to be followed when turning in a hazardous material or disposing of hazardous waste. It also educates all staff at GRC on hazardous material and hazardous waste handling and waste reduction/minimization. The WMT coordinates the transfer of the hazardous materials and wastes to Building 212, the Central Chemical Storage Facility, for temporary storage (90-day maximum for materials determined to be a hazardous waste) while a means of reuse, recycling or disposal is determined.

The WMT determines whether hazardous material can be reused, recycled, or needs to be disposed of as hazardous waste. It coordinates the method of disposal being used with ECT. WMT arranges for a waste disposal contractor to pick up and deliver the hazardous waste to a disposal facility, as required. It reviews all supporting documentation for compliance with the provisions of Title 49 CFR, Department of Transportation, for the shipment of hazardous materials and Title 40 CFR, EPA, for the disposal of hazardous wastes.

The WMT prepares, packages, marks, labels, and certifies the packaging and crating of materials and wastes for shipment. It prepares Uniform Hazardous Waste Manifests for items such as oils, solvents, chemicals, and hazardous soils not covered by other Facilities Division contracts in accordance with EPA and DOT specifications. WMT tracks all manifests to ensure they are accounted for and properly signed. It maintains original files on all hazardous and non-hazardous waste shipments for regulating agency review. WMT provides and maintains all records on required hazardous waste management and DOT

training for GRC. It coordinates and provides required annual training updates and prepares required regulatory and NASA reports.

A8.c Solid Waste Management

It is the policy of GRC to reduce solid waste by finding and using methods of reuse and recycling for all discarded materials; to comply with all Federal, state, and local regulations governing the generation, storage, shipment, and disposal of solid waste; and to conserve resources.

Solid waste is defined as paper, cardboard, tin cans, metal, glass, rubber, plastic, landscaping brush, wood, garbage and other miscellaneous debris both inside containers and in the immediate vicinity of the containers. All solid waste is recyclable with the exception of the garbage and miscellaneous debris.

A contractor is responsible for the total work effort associated with solid waste removal at GRC. In addition, the contractor ensures that only licensed landfill/recycling facilities are used for disposal of GRC's solid waste. The solid waste contract is managed by LTID.

GRC personnel are asked to sort and place recycled items in designated, provided containers. A contractor picks up all sorted material and maintains their segregation during transportation off-site to the recycling station location. NASA has a requirement to ensure against downgrading of white paper by segregating different types of paper products. The categories of paper products are: 1) white ledger paper, 2) mixed paper (including telephone books and newspaper), 3) corrugated paper containers, and 4) magazines. The volume and weight for all paper categories are reported back to GRC.

GRC participates simultaneously in the collection of phone directories and magazines during the phone directories recycling drive, sponsored by the Cuyahoga County Solid Waste District each year.

The recycling program includes paper, telephone books, magazines, newsprint, cardboard, laser printer toner cartridges, scrap metals, and aluminum beverage cans. GRC's solid waste disposal contract includes the efforts for recycling to specify that the contractor must separate out and recycle plastic, cardboard, glass, wood, newsprint, aluminum, and ferrous metals from the waste stream and any other identified recyclables.

Monthly reports of recyclable materials collected from GRC list the dates, locations and weight of material picked up, and are documented and filed by LTID.

A8.d Pollution Prevention

The Pollution Prevention (P2) and Greening the Government (GtG) Plan was designed to be consistent with the goals and requirements of laws and regulations (federal, state and local), of Executive Orders, of NASA mission and policies, and of the GRC goals and policies.

A very important element in the P2 program is the Pollution Prevention Opportunity Assessment (PPOA). A PPOA is a project-specific systematic evaluation of a process or operation to characterize all aspects of the process or operation, define the environmental impacts of the process, associate impacts and wastes with specific unit operations, and assign related costs and liabilities to specific wastes and management practices. Alternative products, processes and operations that reduce environmental impacts, plus health and safety hazards are identified. Vendor information is included to facilitate rapid implementation of the PPOA. Considerations used to rank PPOA's for possible implementation include environmental compliance, facility mission impact, environmental benefits, ease of implementation and cost savings.

NASA GRC policy dictates that annual environmental objectives and targets will be established by the Environmental Pollution Control Board as part of the Environmental Management System (EMS) operation. The EMS P2 projected outcomes for GRC during the year 2002 included:

- Identify at least 10 pollution prevention activities
- Implement at least 5 pollution prevention activities
- Identify at least 3 solid waste reduction, reuse or recycling opportunities
- Implement at least 1 solid waste reduction, reuse or recycling opportunities
- Identify at least 1 activity for reducing construction solid waste.

GRC has established an affirmative procurement program for purchase of environmentally preferable materials as identified by the EPA in 40CFR 247, Comprehensive Procurement Guideline for Products Containing Recovered Materials. GRC uses NPG 8830, NASA Procedures and Guidelines for Affirmative Procurement of Environmentally Preferable Goods and Services.

The Pollution Prevention Team serves as an advisory group for the entire P2 program. Its members collect P2 and GtG data as needed for records, reports and documents. They also select activities for PPOAs and request experts for assistance, as necessary. The team recommends P2 Implementation Projects and recommends the team members to implement them.

A list of the Pollution Prevention Team's main goals for 2003 follows:

- Life Cycle Analysis Development and Implementation
- Performance Testing of Bio-diesel fuel
- MEK Replacement
- Hangar Iridite Replacement
- Garnet Recycling System Installation
- Study on Propane to Methane Conversion on Forklifts
- Tyvek Recycling
- Real Time Monitoring System Installation and Testing at Plum Brook
- Affirmative Procurement / Environmentally Preferred Products Application Categories for Product Testing

GRC's Spill Prevention, Control, and Countermeasure Plan (GRC, September 2001) describes procedures for the prevention and control of oil spills, including PCB-containing oil spills, which may enter any of the on-site sewer systems. The Plan contains sections on regulatory compliance, program responsibilities, training, spill reporting, location of response equipment, and emergency response procedures. The Plan is written as part of Annex Q of the GRC Emergency Preparedness Plan.

A new Pollution Prevention Greening the Government plan was established in 2002 pursuant to Executive Order 13148. This plan can be found in Chapter 6 of the Environmental Programs Manual.

A9 TOXIC SUBSTANCES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to toxic substances. Relevant chapters include:

- Chapter 3 Water Pollution Control
- Chapter 4 Air Pollution Control
- Chapter 5 Management Of Hazardous Materials And Waste For Reuse, Recycling, Or Disposal
- Chapter 6 Pollution Prevention and Greening the Government Plan (P2 and GTG Plan)
- Chapter 7 Polychlorinated Biphenyls Policy
- Chapter 9 Asbestos
- Chapter 10 Synthetic Inorganic Fiber Program
- Chapter 13 Lead
- Chapter 14 Elemental Mercury
- Chapter 17- Solid Waste
- Chapter 34 Handling and Disposal of Soil

A9.a Exposure Standards and Effluent Limits Under the Clean Water Act

Refer to Chapter 3, **A3.d Wastewater Discharges** for a discussion of exposure standards and effluent limits under the Clean Water Act.

Lewis Field's NPDES permit prohibits the discharge of toxic water pollutants. Only one toxic substance, mercury, has a monitoring requirement in Lewis Field's permit. There is no stated limit. Results of the monitoring program have yielded occasional low detections of mercury. Ohio EPA has not commented on these reports.

A9.b Exposure Standards and Effluent Limits Under the Clean Air Act

Hazardous air pollutants, HAPs, are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. Title III of the Clean Air Act is working to reduce air toxics releases of 188 pollutants to the environment. Examples of HAPs include benzene, perchlorethlyene, methylene chloride, dioxin, asbestos, toluene, cadmium, mercury, chromium, and lead compounds.

The Federal program, National Emission Standards for Hazardous Air Pollutants (NESHAP), has gone through many revisions and updates to regulate many of the potentially hazardous chemicals that are released into the air. Originally NESHAP only covered seven pollutants: arsenic, asbestos, beryllium, mercury, radionuclides, benzene, and vinyl chloride. Today a more elaborate program regulates emissions of HAPs from sources that emit listed HAPs. An industry-specific list was used to determine the major sources of HAPs. The regulations also allowed the federal government to regulate any sources that pose a threat of adverse effects to health and the environment. Any source that is affected had to comply with the maximum achievable control technology (MACT) standards.

Title III of the CAAA authorized the establishment of regulations on emissions of listed HAPs. These rules are in addition to the older NESHAP regulations for asbestos, inorganic arsenic, benzene, beryllium, mercury, radionuclides, radon, vinyl chloride, and fugitive emissions. In general, the NESHAP requirements are to install the Maximum Achievable Control Technology (MACT) for specific operations. The MACT baseline is set as the most effective 12% of the controls used in an industrial

category. A major source is a facility with the annual potential to emit 10 tons of any single HAP or 25 tons of a combination of 2 or more HAPs. There are some NESHAP requirements that apply to area sources. An area source is non-major activities located at a non-major facility.

Currently, Lewis Field is classified as minor for HAP. This means that no single operation at Lewis Field is a major source of HAP and no combination of sources are considered as a major source of HAP. Also no area source NESHAP-MACT regulations are applicable at Lewis Field. Should this classification change, Lewis Field's control of HAP emissions could be governed by the developing NESHAP and MACT standards covering any of the operations occurring at the Center. Some examples will be the use of boilers, process heaters, engine testing, reciprocating internal combustion engines, and various surface coating operations.

A9.c Management Programs Implemented for Toxic Substances Control Act (TSCA)

PCBs and existing techniques for control

Polychlorinated biphenyls (PCB's) are chemicals which were once widely used as dielectric fluids in electrical transformers and in solvents, oils, heat transfer fluids, hydraulic fluids, inks, and other products. PCB's can present a risk to human health and are regulated under the Toxic Substances Control Act of 1976, Public Law 99-519 (40 CFR Part 761). These regulations ban the further manufacture of PCB's and establish strict rules for the handling and disposal of PCB's still in use. Items are classified as "PCB" ("PCB transformers," "PCB capacitors," etc.) if they contain >500 parts per million (ppm) PCBs. Items are classified as "PCB contaminated" if they contain <500 ppm but >50 ppm, and "non-PCB" if they contain < 50 ppm PCB's.

GRC has an ongoing PCB abatement program that includes transformers, capacitors, and hydraulic oil systems. Many pieces of equipment once containing PCB fluids have been removed or remediated. As of 1994, no PCB transformers remained on site. In 2002, several PCB items were shipped for disposal including capacitors, ballasts, oil, and miscellaneous debris (GRC 2002 PCB Annual Document Log). Building 136 is used for secure PCB storage when needed. As of the close of 2002, there were no PCB-contaminated transformers remaining in service at outdoor locations at Buildings 6, 8, 105, and 201. The Cleveland Electric Illuminating Company also has transformers onsite, some of which may be PCB-contaminated.

An assessment of spill containment provisions for oil-insulated electrical equipment in the high voltage power system was completed in 1995 (Raytheon, 1995). The study recommended upgraded spill containment at several locations. The highest priority was at Substation F (Structure 41). These four transformers were replaced in 2001. The study also recommended that several pieces of equipment be tested to determine their PCB status. The testing is nearly complete.

Four PCB transformer spills have been recorded since 1992. Three were small leaks of PCB oil or mineral oil with PCB concentrations greater than 50 ppm. The fourth incident occurred in June of 1994 due to the over-filling of a transformer at Substation A. This resulted in the loss of 132 liters (35 gallons) of mineral oil with PCB concentrations of 10 ppm. The site was subsequently remediated.

Asbestos and Synthetic Inorganic Fibers and existing techniques for control

Asbestos refers to a variety of naturally occurring mineral silicates once widely used for heat and acoustical insulation, fireproofing, friction products, reinforcing material, and other applications.

Asbestos can present a potential hazard to health; its use, removal, and disposal are regulated under TSCA and the Occupational Safety and Health Act (OSHA), Public Law 91-596. Asbestos is also regulated as an air pollutant under the NESHAPs provisions of the Clean Air Act (40 CFR Part 61). The Ohio Department of Health issues rules for asbestos abatement contractors and workers at OAC 3701-34.

Asbestos maintenance and abatement are ongoing activities at GRC. A visual asbestos survey of the facility was conducted in 1994. A Facility Asbestos Survey begun in 1998 should be complete in 2003. New uses of asbestos-containing materials are prohibited except where there is no acceptable substitute. Since 1992, GRC has used a blanket permit authorization for asbestos spill response, operations and maintenance activities.

Synthetic inorganic fibers include materials such as fiberglass, mineral wool, and refractory ceramic fibers. Due to health concerns regarding these substances, GRC has established operational procedures and maximum exposure limits and action levels for these substances. A description of this program can be found in Chapter 9 of the *GRC Environmental Programs Manual*.

Lead and existing techniques for control

GRC maintains a database of the lead-containing materials sampling results and an on-going facilities lead survey is being conducted. If an Area of Concern (AOC) with lead-containing materials is encountered, the area is contained and / or remediated.

All lead containing materials are collected and disposed of in accordance with environmental regulations. The Waste Management Team (WMT) is responsible for the disposal of lead contaminated waste.

Radon and existing techniques for control

The US EPA has established a guideline of 4 pico curies of radon per liter of indoor air. This guideline is based on lifetime exposure, which is defined as occupying an area 75% of the time for 70 years.

All NASA Centers were required to complete a radon monitoring program to comply with the Indoor Radon Abatement Act. Alpha-Track detectors were used for the test period and the detectors were evaluated by a certified laboratory.

Lewis Field buildings were screened for testing based on occupancy, geographical location and soil content. Those buildings which were identified as being located in areas that were ideal for radon migration were chosen for the actual radon test program. Radon testing was conducted during all four seasons to gather data during various conditions existing in buildings due to changes in temperature, ventilation, air change rates, etc. For each test round, other data recorded were barometric readings, negative air pressure detected inside buildings, air change rates and overall weather conditions.

The maximum level of radon detected at GRC was 3.1 pico curies. The buildings with this level of radon were located close to the Rocky River and Abram Creek ravines, where there is exposed shale rock, which usually has a high content of radium. In general, the buildings at Lewis Field have a high ventilation rate, which lessens radon gas build-up.

According to the limit of 4 pico curies per liter of indoor air, established by the US EPA, Lewis Field buildings do not have a radon gas problem, with no mitigation methods necessary.

A10 PESTICIDES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to pesticides and herbicides. Relevant chapters include:

- Chapter 31 Pest Control

A10.a Initiatives to Reduce Pesticide Use

It is a goal of GRC to exercise integrated pest management practices whenever pest control is necessary. GRC policy is to store, apply, transport, and dispose of pest control materials according to all applicable Federal, State, and local statutes. It is a goal of GRC to minimize the storage, use, and disposal of pesticides onsite. Pesticide use at GRC is exercised with a goal of minimizing both human exposure and adverse environmental impacts.

A10.b Management Practices

The GRC Facilities Division manages the pest control program at Lewis Field. EMO recommends and advises actions that will lead to achieving goals and regulatory compliance. EMO also recommends personal protective equipment.

The Facilities Division is responsible for verifying that pesticide applicators receive required training and physical examinations. Facilities Division also maintains the following records:

- Pesticide Applications Records
- Training Records
- Dates of Physical Examinations

Non-selective herbicides are used at Lewis Field in small quantities for vegetation control. Herbicides are applied seasonally and only to the extent needed. Pesticides are used to control crawling insects in buildings and near ornamental trees. No restricted pesticides are used. Fertilizer is applied only to newly seeded areas. Chemicals are stored in Building 107 and equipment is stored in Building 208. Pesticides are stored in flammable materials cabinets in a secured area. A running inventory of pesticides on hand is maintained by Facilities Division. Pesticides are not disposed and are used for their intended purposes.

Pesticide and herbicide activities are carried out by a contractor. The facility landscaping budget has been reduced in recent years, which is a factor in the decreased use of pesticides and herbicides. For example, chemicals are no longer applied to ornamental trees, many of which are nearing the end of their normal life span.

A list of pesticides commonly used at Lewis Field follows in Table A10-1.

Table A10-1 2002 Pesticide and Herbicide Usage List for Lewis Field

Name	Chemical Name	Manufacturer	Type*
Roundup	Glyphosate	Monsanto	H
Apicide	Carbaryl	Mystic Chemical Products Company	I
Double Shot	Pyrethrins Piperonyl Butoxide Technical Permethrin	ZEP Manufacturing Company	I
Conquer	Esfenvalerate	Paragon Professional Pest Control Products	I
Total Release Foggers	2-[(1 methy 4-2-4 phenoxyphenoxy) ethoxy] Pryidine (Pyrethrius) (N-octyl bicycloheptene dicarboximide) Permethrin(3-phenoxyphenyl methyl) Cis Trans 3- (2,2-dischloroethenyl) related compounds	ZEP Manufacturing Company	I
Scythe	Pelargonic Acid Related Fatty Acids (c6-c12)	Mycogen Corporation	H
Trimac	Dimethylamine Salt of 2-Methyl 4 Chlorophenoxyacetic acid Dimethylamine salt of 2 (2 methyl-4 chlorophenoxy) propionic acid Dimethylamine salt of Dicamba 3,6-dichloro-o-anisic acid	PBI/Gordon Corporation	H
Primo Max	Trinexapac-Ethyl	Novartis Crop Protection Inc.	H
Blastem	Tetramethrin permethrin piperonyl butoxide Technical	Sherwin Williams Spray-on Division	I
Baygon	2-(1-Methylethoxy) Phenol methylcarbamate)	Miles Inc.	I
Tempo	Cyfluthrin, cyano (4 floura-3 phenoxyphenyl) Methyl 3- (22-dichloroethenyl) 22-dimethylcyclopropane carboxylate	Bayer Corporation	I
Maxforce	Fipronil (5 amino-1-(2,6 dicloro-4-trifluoromethyl) Phenyl) 4-(I,R,S) triflouromethyl) sulfinyl) 1h-pyrazole-3-carbonitrile	Maxforce Insect Control Systems	I
Talstar Lawn & Tree Flowable	Bifenthrin	FMC	I
Horticultural Oil Insecticide	Refined Petroleum Distillate	Lesco	I
Hexygon	Hexythiazox trans-5-(4-chlorophenyl)-N-cyclohexyl-4-methyl-2-oxothiazolidine-3-carboxamide	Gowan Company	H
Floramite	Bifenzate:hydrazine carboxylic acid, 2-(4-methoxy-[1,1-biphenyl]-3-yl)	Uniroyal Chemical	I
Tempo 20 WP	Cyfluthrin, cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate	Bayer Corporation	I
Eagle WSP	Myclobutanil	Rohm and Haas Company	I
Tri-Power Selective Herbicide	Dimethylamine salt of 2-methyl-4-chlorophonoxyacolic acid	Riverdale Chemical Company	H
Merit 0.5 G	Imidacloprid, 1-[(6-Chloro-3-pyridinyl)methyl]-N-nito-2-imidazolidinimine	Bayer Company	I

*H=herbicide
*I=insecticide

A11 RADIOACTIVE MATERIALS AND NON-IONIZING RADIATION

The GRC Environmental Programs Manual contains detailed policies and procedures related to ionizing & non-ionizing radiation sources. Relevant chapters include:

- Chapter 28 Ionizing Radiation Protection Program
- Chapter 29 X-Ray Equipment
- Chapter 30 Non-Ionizing Radiation

GRC's Radiation Protection Program establishes the administrative requirements, technical guidelines, regulatory compliance, health physics practices and procedures for facilities and users of ionizing and non-ionizing radiation sources and equipment. GRC has a "specific materials license" with the Nuclear Regulatory Commission (NRC) and is allowed to possess those radioactive sources specifically listed in that license. GRC also possess other sources which are generally licensed by the NRC.

A11.a X-Ray Generating Equipment

Radiography

Radiography is a process that uses ionizing radiation sources to x-ray materials for the purpose of identifying cracks and other flaws or damage, located in areas of structures or components that cannot be seen with normal visual examination.

Radiographic procedures are done with portable x-ray units and other sources such as Iridium (most common), Cesium and Cobalt. To achieve the depth necessary to x-ray some materials, the sources that are used create very intense fields of radiation, but the exposures last only for a few seconds, and limit exposure by the time factor.

Radiography is done at Lewis Field and has the potential for exposing the greatest number of members of the public and employees, because some radiographic procedures are performed in unshielded facilities and outdoor locations. Lewis Field has a shielded radiography facility in Building 14. When it is not possible to transport parts to the radiography facility, exposure is controlled by maintaining appropriate radiation levels at a safe distance from the source, and limiting access to the area with barriers and warning signs.

Contractor radiographers are required to provide GRC's Radiation Safety Officer (RSO) a copy of maintenance, training, instrument calibration records, leak test records, licenses and all other applicable requirements for the procedure being performed and the type and strength of the source being used. GRC's radiographer is required to provide annual maintenance records to the RSO for the portable x-ray units.

Analytical X-Ray Equipment

GRC researchers utilize analytical x-ray equipment for various experimental projects. All facilities and x-ray units have appropriate shielding and containment barriers. X-ray equipment is regularly surveyed for leakage by the GRC EMO Health Physics Team. Users have access to survey instruments and are able to survey their equipment during each use or after maintenance has been performed.

Exposure potential from sealed sources and x-ray equipment for members of the public is highly unlikely. Occupational workers have a low probability of exposure while changing/positioning target materials or performing maintenance on equipment, unless the shielding fails or is removed.

Diagnostic X-Ray Equipment

The diagnostic x-ray unit is maintained and operated by a contractor occupational medicine staff. The x-ray machine is housed in the Medical Services area of Building 15 at Lewis Field. The room housing the diagnostic unit is equipped with the appropriate shielding for the type of x-rays being generated. Diagnostic x-ray services are available to all GRC personnel, and are administered by trained, certified medical professionals.

The diagnostic unit and all associated chemicals and materials comply with the applicable Food & Drug Administration standards and regulations. The Ohio Department of Radiological Health conducts bi-annual audits, to ensure that all procedures and practices are in compliance with the requirements for human exposure to diagnostic x-rays. The GRC RSO receives a copy of the audit reports, and does a follow-up on corrective actions, if radiation safety deficiencies are identified.

Portable Density Gauges

Portable density gauges contain ionizing radiation sources to measure material composition and density. The radiation sources are shielded and pose no exposure hazard unless the gauge is damaged or crushed. The potential for a gauge being damaged is relatively high since these devices are primarily used at construction sites where heavy equipment is also in use. Density gauges are routinely used at Lewis Field, and under normal circumstances, the only radiation protection requirement for gauge users is a personal dosimeter. Gauges can create a general population hazard if damaged, lost or stolen. Control is maintained by physically observing the gauge when in use, and physically securing the gauge when stored or not in use at the site. The individual who is responsible for radiation safety at the site is instructed to notify the GRC RSO if the gauge is damaged, stolen or lost.

Sealed Sources

GRC's largest inventory of radiation sources is sealed sources (see Tables A11-1 and A11-2). They are maintained by the EMO's Health Physics Team, which specializes in radiation protection technology, procedures, and practices. Ninety percent of these sources are maintained in storage and are held in dedicated health physics areas. Leak tests are performed periodically to make sure the seals are intact.

Some sealed sources are used by researchers who are trained occupational radiation workers and are assigned personal monitoring devices as part of GRC's dosimetry program. The monitoring devices are sent to an accredited laboratory on a monthly basis for an evaluation of each individual's exposure. Dosimetry reports contain quarterly and annual radiation doses and are reviewed monthly by the GRC RSO.

Table A11-1 Ionizing Radiation Sources

Type of Source	Population Exposed	Hazard Potential
X-Rays (Analytical)	Occupational Users	<Annual occupational dose limit*
X-Rays (Diagnostic)	Patients	Limits for specific diagnostic evaluations
	Occupational Medicine Staff	<Annual occupational dose limit*
Radiography	Lewis Field Workforce Radiographer	Low Probability High Probability
Sealed Sources	Radiation Safety Staff	<Annual occupational dose limit*

***Annual Occupational Radiation Exposure Limit = 5 Rem**

Table A11-2 Non-Ionizing Radiation Sources

Type of Source	Population Exposed	Hazard Potential
Class I Lasers	Researchers	None
Class II Lasers	Researchers	Extremely Low
Class IIIB Lasers	Researchers	Unlikely with proper controls
Class IV Lasers	Researchers	Unlikely with proper controls
Radio Frequency	Lewis Field Workforce	< Limits of adopted standard
Electromagnetic	Lewis Field Workforce	< Limits of adopted standard

A12 NOISE, SONIC BOOM, VIBRATION

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to noise impacts. Relevant chapters include:

- Chapter 11 Hearing Conservation Program

Occupational exposure to noise is regulated by OSHA in 29 CFR Part 1910.95. The noise exposure limit for workers is 90 dB (A) as a maximum daily time-weighted average. (The "decibel-A" scale, written as dB (A), is a frequency weighting network representative of the response of the human ear.) NASA has set a more conservative worker exposure limit of a time-weighted average of 85 dB (A).

Some communities adjacent to Lewis Field have local noise ordinances. These are generally in the form of zoning restrictions for noise levels at residences and commercial facilities and for the operation of noise-emitting devices during certain times of the day.

A12.a Environmental Setting

Several noise sources exist in the general vicinity of the Lewis Field site. Foremost among these is the Cleveland Hopkins International Airport which is adjacent to Lewis Field. Other, lesser noise sources nearby include a Ford Motor Company factory and sources of traffic noise such as two major Interstate highways and a large exhibition hall (the I-X Center).

A12.b Lewis Field Operations

Noise generated at Lewis Field can be attributed to such sources as research operations (e.g., wind tunnels and engine test cells), transient noises such as releases from valves, NASA aircraft, construction activities, and traffic noise. Research sources such as the wind tunnels generate noise from the movement of rushing air. The central process air system in Building 64 can generate high noise levels from its compressors, exhausters, heaters, chillers, and other equipment. Recent surveys indicate that, with the exception of transient noise spikes, the highest on-lab noise levels measured near operating systems are in the 90-95 dB(A) range, with a maximum of 102 dB(A). Transient peaks in noise levels may occur due to the action of relief valves, vent noise, etc. Aircraft housed in the Flight Research Building (Building 4, the hangar) can taxi directly to runways at Cleveland Hopkins International Airport. Aircraft operations can generate maximum environmental noise levels between 80 and 90 dB (A) in nearby pedestrian areas on the Lewis Field site. Construction generates noise from machinery and vehicular traffic.

Responsibility for noise issues is delegated to the Noise Exposure Management Team of the Environmental Management Office. The Team manages programs in hearing conservation, acoustical and noise control engineering, and community noise control. Annual hearing conservation training and an audiogram are required for designated employees. Hearing protection is provided to all employees exposed to noise levels above 80 dB (A) and is required in areas where noise levels are above 85 dB(A). When hearing protection cannot reduce noise levels to less than 85 dB(A), the time a worker is allowed in high-noise areas is restricted to meet a time-weighted average exposure limit of 85 dB(A).

The community noise control program focuses on resolving local noise complaints and instituting appropriate measures as needed. All complaints are addressed personally by the GRC noise program manager. The general noise level of Lewis Field is well below the average day/night sound level of the Cleveland Hopkins International Airport. Noise levels at the Lewis Field fence line are generally below 70 dB(A), with much of this noise attributable to off-site sources. Wind tunnel noise at the fence line is less than 55 dB.

A13 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL FACTORS

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to historic and archaeological resources. Relevant chapters include:

- Chapter 36 Cultural Resources

A13.a Historic Setting

NASA GRC was established in 1941 by the National Advisory Committee for Aeronautics (NACA). It was one of three such centers nationwide. Groundbreaking ceremonies for the new Lab were held at the site in Cleveland on January 23, 1941 for the new NACA Aircraft Engine Research Laboratory. In April 1947 the Cleveland laboratory was renamed the Flight Propulsion Research Laboratory to mark its transition from an engine laboratory, charged with assisting industry with its wartime development problems, to a laboratory with the freedom to explore areas in propulsion research that seemed to hold promise for the future. The National Advisory Committee for Aeronautics was reconstructed into the National Aeronautics and Space Administration (NASA) on October 1, 1958. The lab became part of the foundation of the new agency and was renamed the NASA Lewis Research Center. On March 1, 1999, the Lewis Research Center was officially renamed the NASA John H. Glenn Research Center at Lewis Field.

Lewis Field undertook a cultural reconnaissance survey in 1996 to inventory National Register eligible resources in its possession (Gray and Pape, 1996). The survey cites two Lewis Field facilities which have been designated as National Historic Landmarks. See Table A13-1.

Table A13-1 National Historic Landmarks at Lewis Field

Building Name	Building Number	Status
Rocket Engine Test Facility (RETF)	202	National Historic Landmark
Microgravity Research Laboratory (Zero Gravity Facility)	110	National Historic Landmark

The RETF (Building 202) was constructed in 1956. It was listed as a National Historic Landmark as part of the 1984 Man in Space thematic nomination. The RETF and the former Rocket Operations Building (Building 100) were listed as an integrated test facility significant for their contribution to the development of lightweight, regeneratively-cooled hydrogen engines. The facility was used for the development of the Centaur and Saturn rocket engines (which launched the Apollo astronauts to the moon) as well as the main engines for the Space Shuttle.

In April 1996, the NASA Zero Base Review identified the RETF for closure. The facility is currently in "mothballed" status. RETF is scheduled for demolition in August 2003. The Draft Master Plan Update (1999) for Cleveland Hopkins International Airport provided a basis for an Airport Layout Plan (ALP). The preferred plan required that the RETF be demolished to make room for runway expansion. This proposal was one alternative considered in *Cleveland Hopkins International Airport Final Environmental Impact Statement (FEIS) Section 303(c) and 6(f) Evaluation* (June 2000). Impacts to the RETF and proposed mitigation measures were discussed in Chapter V of the FEIS. Mitigation requirements are documented in *Memorandum of Agreement Among the Federal Aviation Administration, The National Aeronautics and Space Administration, The Ohio State Historic Preservation Officer and The Advisory*

Council on Historic Preservation Regarding Proposed Development at Cleveland Hopkins International Airport, Cuyahoga County, Ohio (October, 2000). Mitigation measures are currently in progress.

Among the many mitigation measures required of the City of Cleveland, the most outstanding efforts include:

- Recordation of the RETF NHL to the standards set by the Historic American Engineering Record (HAER).

- Photography of the existing condition of the RETF, and cataloguing the photographs, videotapes, films and written records which describe the RETF and its context.

- Videotape interviews of persons who worked in the RETF and associated research programs within the transferred land during the period of significance of the RETF. The City will transcribe the interviews into a written document.

- Preparation of a comprehensive peer-reviewed history of the RETF, its research programs, and contribution to human space flight (covering its role in rocket technology programs, the Apollo missions, the Advanced Space Shuttle, Orbit Transfer Vehicles and Space Station Project).

- Preparation of a web-based presentation on the RETF, its research programs, and contribution to human space flight incorporating photographs, video clips, and written materials for display through the NASA website.

- Production of five minute and a twenty minute videotape programs covering the history of the RETF, its research programs, and contribution to human space flight.

As a means of verifying the 1996 Gray and Pape conclusions regarding eligibility of the South Area as a potential historic district, GRC contracted with Gray and Pape to reevaluate properties. The report, *Evaluation of Architectural Resources: South Area, John H. Glenn Research Center at Lewis Field* (June, 2000) concluded that the only culturally significant structures in the South Area were those identified in the RETF nomination form.

The Zero Gravity Facility (Building 110) was constructed in 1966. It was listed as a National Historic Landmark as part of the same Man in Space thematic nomination as the RETF. The facility is used to study the behavior of aerospace components, liquids, gases, and combustion in a simulated microgravity environment and has supported all aspects of the United States space program. The key component is a 6.1 meter (20 foot) diameter drop chamber which is 143 meters (470 feet) deep. The chamber can be brought to near vacuum to lower drag on the falling test article. A weightless state can be achieved for up to 10 seconds and the test article retrieved without damage. This is the only known facility of its size capable of performing tests in a reduced gravity environment.

In 1987, the Icing Research Tunnel (Building 11) was named an International Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers. This facility has a unique heat exchanger and a spray system that simulates natural icing clouds. The facility is the world's largest refrigerated icing tunnel and has been the site of groundbreaking research in aircraft icing phenomena.

The goals of the 1996 cultural resources survey investigation included development of a historic context for the facility through historic research, and survey of all buildings and structures. The final report is titled *Overall Cultural Resource Reconnaissance Survey of NASA Lewis Research Center.* It identified a

potential National Register-eligible historic district within the Central and South Areas of the facility significant for its associations with national aeronautic and aerospace programs and important technological and scientific advances in those fields. The report noted that if the identified historic district was not found to meet National Register eligibility criteria, that certain buildings and complexes within the larger facility appeared to meet the eligibility criteria as individual resources. These resources included the Icing Research Tunnel, the 10-foot by 10-foot Supersonic Wind Tunnel, and the Altitude Research Tunnel.

In 2001, Gray and Pape was contracted to reevaluate the conclusions of its 1996 report for the Central Area at Lewis Field. The *Draft Report for Supplemental Overall Cultural Resources Survey for the Central, North, And West Areas of Lewis Field* (June, 2001) concluded that the Central Area is eligible as a Historic District. As of the release date of this chapter, the SHPO has not commented on the 2001 Supplemental Survey report. A map (Figure A13-1) of the proposed historic district is located at the end of this chapter.

A13.b Archeological Resources

While detailed archeological surveys do not exist for the entire site, the 1996 Gray and Pape cultural resources survey of Lewis Field performed an archeological resource predictive model and prepared a sensitivity map. Portions of Lewis Field were considered very sensitive for potential archeological resources.

One archaeological site has been reported in the vicinity of Building 501 (Jones, 1996). The "Dean Site" (State Number 33 Cu 133) is known from anecdotal reports and is said to have contained relics from the Archaic and Woodland periods. The site is probably no longer extant.

In support of the *Cleveland Hopkins International Airport Final Environmental Impact Statement*, Environment and Archaeology Limited Liability Company undertook a limited Phase I Archaeology Survey at Lewis Field in 1998. The area investigated was the South Area within the area of construction impacts. The survey indicated that no significant or potentially significant archaeological sites are located within that area.

A second Phase I Archaeology Survey was performed by Parsons Engineering Science, Inc. (2000). This study investigated areas targeted for facilities relocation. A total of 36,502 square meters (9.02 acres) at four locations at Lewis Field were subjected to a systematic Phase I. The parcels, designated letters A through F, were scattered in the Central, South, and West Areas. Excavations at Lewis Field resulted in the identification of two positive shovel test pits (STPs) within a layer of fill. Consequently, the artifacts recovered from that area are part of a series of fill deposits and lack integrity. No artifacts were recovered throughout the remainder of areas tested at Lewis Field. STPs in most areas tested revealed heavily disturbed soils. Given the absence of artifacts and the disturbed nature of the soils in these areas, it is unlikely that any significant cultural materials remain. Consequently, no further archaeological investigations were considered warranted at Lewis Field in conjunction with this project.

Additional archaeological investigations were undertaken at the Lewis Field and PBS project areas during November 2002. The additional Phase I archaeological field investigations were conducted to support recent changes in project plans. A total of 5,666 square meters (1.4 acres) at Lewis Field were surveyed for evidence of cultural materials. No archaeological deposits or other significant cultural remains were encountered during the November 2002 field investigations.

A13.c Cultural Institutions in the Vicinity of Lewis Field

Several public and community facilities are located within an approximately 6.4 kilometers (4 mile) radius of Lewis Field including 39 schools, 70 churches, five libraries, two hospitals, and seven nursing homes.

Numerous public parks that have the potential to be impacted by Lewis Field activities are located in the surrounding communities:

- **Brook Park:** Abram Creek Recreation Area
- **City of Cleveland:** Crossburn Park, Emory Playfield, Gilmore Playground, Gunning Park, Jefferson Park, McGowan Park, Riverside Park, and Terminal Playground
- **Fairview Park:** Fairview Park
- **Rocky River Reservation** is located in Berea, Brook Park, Cleveland, Fairview Park, Lakewood, North Olmsted, and Olmsted Township. The reservation includes the Rocky River Nature Center and the Big Met, Little Met, and Mastick Woods golf courses.

Figure A13-1 Proposed Historic District

Recommended Contributing/Noncontributing Buildings and Historic District Boundaries. (Figure 11 from Gray & Pape, *Overall Cultural Resource Reconnaissance Survey of NASA Lewis Research Center, Cleveland, Ohio [McClane et al. 1996])*

GRAY & PAPE INC.
CULTURAL RESOURCE CONSULTANTS

A14 ECONOMIC, POPULATION, AND EMPLOYMENT FACTORS

A14.a Population of the Cleveland Area

The GRC Lewis Field site is located in Cuyahoga County in the greater Cleveland metropolitan area. The 2000 United States Census gives the population of Cuyahoga County as 1.4 million people and the Cleveland-Akron Metropolitan Statistical Area as 2.9 million people.

A14.b Environmental Justice

Executive Order 12898 (1994), *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs Federal agencies to integrate the achievement of environmental justice into their missions. Agencies must ensure that their policies, programs, and activities do not exclude or subject persons or populations to discrimination because of race, color, or national origin.

In response to the EO, GRC has developed an *Environmental Justice Implementation Plan* (Jones, 1996) and a *Supplement to the Environmental Justice Implementation Plan* (SAIC, October, 1997). Five Census tracts were identified within an 8 kilometer (5 mile) "region of influence" which is likely to meet Federal environmental justice criteria for minority or low-income communities (Figure A14-1). The Plan concluded that "...no substantial or disproportionate environmental impacts are currently experienced by any community at either location [i.e., Lewis Field or PBS]." The Plan is being implemented to identify and mitigate potential environmental justice problems and will be revised periodically as needed.

A14.c Health and Emergency Services and Transportation

GRC has an Emergency Preparedness Plan which describes response actions to be taken in the event of an emergency (http://smo.grc.nasa.gov/epp/epp.asp, Revised 8/30/02). The Plan meets various requirements of the USEPA, OSHA, the Federal Response Plan, and the NASA Emergency Preparedness Plan (NPG 8715.2), and is revised periodically.

The NASA GRC fire station was closed in April 1996 after an assessment determined that the Center could effectively rely on local emergency response resources. Fire, medical, and hazardous material emergency response are now provided by the adjacent communities of Cleveland, Brook Park, and Fairview Park. Under the current plan, reported incidents are first investigated by former fire fighters who were reassigned or co-assigned to first responder positions. If deemed necessary, NASA dispatchers call for outside assistance. In an obvious emergency, outside assistance is requested immediately. There is also coordination of emergency services with the City of Brook Park Fire Department and Hazardous Materials Response Team.

EPCRA and EO 12856 directs Federal agencies to provide technical assistance to the Local Emergency Planning Commission in the development of emergency response plans and the fulfillment of community right-to-know responsibilities, if requested, and to the extent practical. GRC has responded to all requests for information from the State and Local Emergency Response Commission. GRC has also supplied the Local Emergency Response Commission with a list of resources and equipment which can be made available in the event of an emergency.

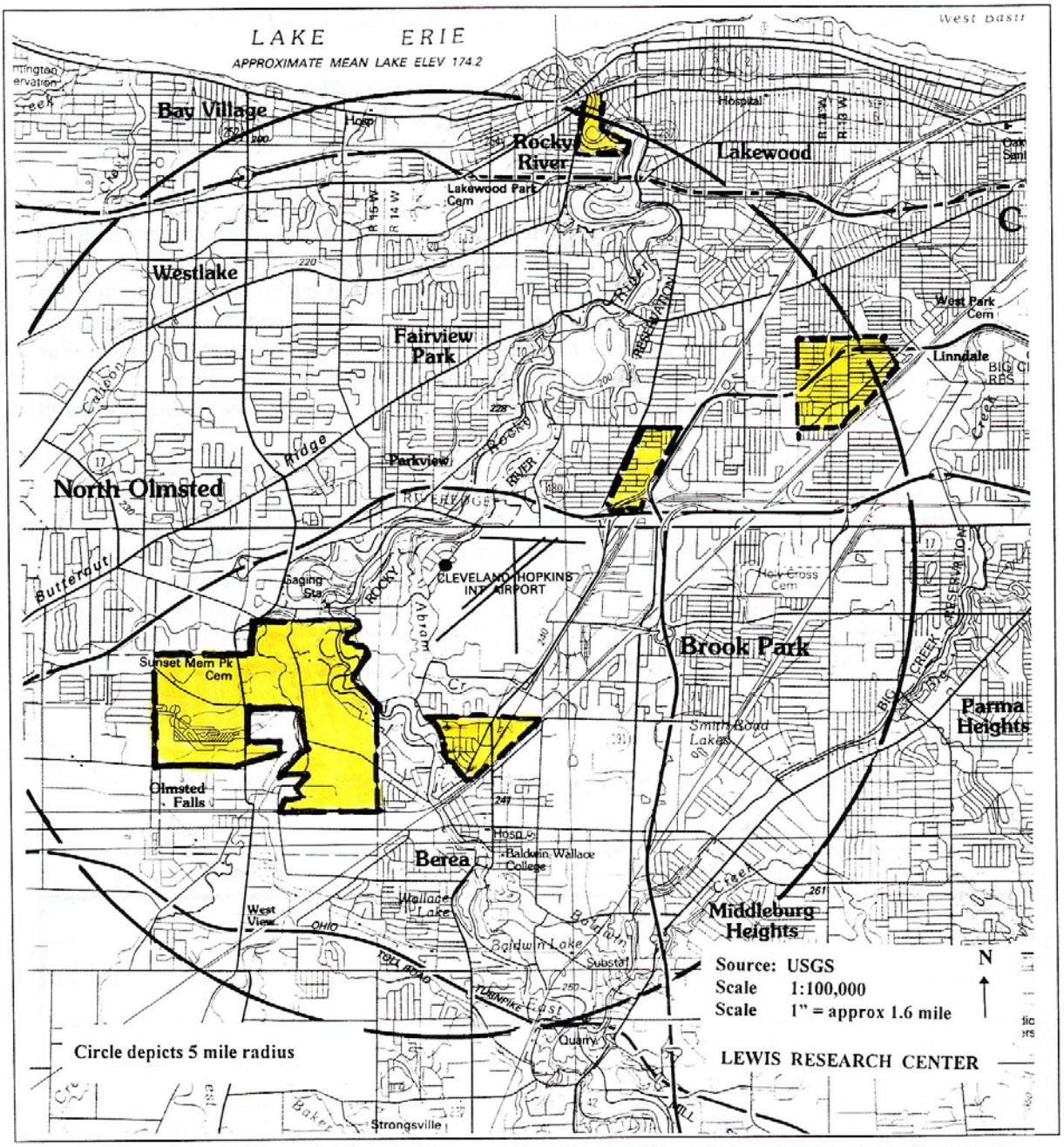


Figure A14-1 Possible Minority and Low-Income Areas near Lewis Field Based on 1990 Census (outlined in bold)

Lewis Field has an on-site medical facility where employees can be seen for acute injuries and illness or occupational injuries during normal working hours.

The transportation network in the vicinity of GRC/Lewis Field consists of two major highways, Interstate-480 and Interstate-71, which provide automobile access and serve as major feeders to the airport. These are heavily-traveled roads which are often congested during rush hour. There are many secondary roads also serving the area. Most commuting to Lewis Field is by automobile. The Greater

Cleveland Regional Transit Authority provides public transportation to Lewis Field. The level of service is limited. A public transportation subsidy program is available to civil servant employees.

Lewis Field is adjacent to the Cleveland Hopkins International Airport, which provides national and some international air service. Cleveland Hopkins serves as a hub for Continental Airlines, a major domestic carrier. NASA aircraft can taxi directly from the Flight Research Building (hangar) to runways at the airport.

A14.d GRC Labor Force

The GRC on-site civil servant population was 1,934 as of June, 2003 with an aggregate annual salary of $148,000,000. This includes both Lewis Field and Plum Brook Station (Table A14-1). The Greater Cleveland Growth Association ranked NASA GRC as the area's 49th largest employer as of March, 2000. Civil Servant Employment levels have declined 33% in the past 11 years at GRC. The contractor population was approximately 1,500 as of June, 2003. In addition, the United States Army has 48 employees on-site as part of the Vehicle Technology Directorate. This group has been on-site for over 30 years and works with NASA staff on joint ventures involving propulsion and ground vehicle engines and transmissions.

Table A14-1 Personnel Levels at Lewis Field

Personnel Classification	May 1992	May 1993	May 1994	Dec. 1994	Dec. 1995	June 2003
Civil servant	2,871	2,786	2,536	2,454	2,312	1,934
Contractor	1,575	1,549	1,548	1,460	1,202	1,500*
Other	218	245	229	237	204	48**
Total	4,664	4,580	4,313	4,151	3,718	3,482

*Includes 300-person off-site Microgravity Contract Staff.
**Resident Army Staff in Vehicle Technology Directorate

Employees are classified as Scientist and Engineer, Professional Administrative, GS Technician, or Wage Grade personnel. GRC has a skilled and educated work force which is a critical component of the science and technology base of the region.

Other employers in the vicinity of Lewis Field include the Ford Motor Company, General Motors Corporation, Case Western Reserve University, Cleveland State University, and medical facilities such as the Cleveland Clinic Foundation and University Hospitals Health System.

Since the groundbreaking at Cleveland on January 23, 1941, for the then Aircraft Engine Research Laboratory of the former National Advisory Committee for Aeronautics, more than $535 million has been invested in the Center's capital plant; estimated replacement cost is approximately $1.7 billion dollars.

A14.e Electric and Gas Utilities

Lewis Field obtains its electricity from The Illuminating Company, a subsidiary of the First Energy Corporation. Electrical consumption was 208,179 MWh in FY 2002 at a cost of $10.9 million. Rates are based on a time-of-day schedule, and when feasible, energy-intensive uses such as the wind tunnels are scheduled to run during off-peak hours. There are four incoming 138-KV overhead lines connecting at Substation A in the South Area. Electric capacity has been reported as 400 MVA.

Qualitative data suggest that approximately one-half of the electricity used is for the major research facilities (SAIC, 1995). These include the wind tunnels and engine and propulsion test facilities. The remainder is used for the smaller research facilities, support facilities, and for institutional purposes. No routine power is generated on site and there are no co-generation facilities.

Natural gas supplies much of the heating needs of the facility. Total consumption was 490,185 MCF in FY 2002 at a cost of $2.7 million dollars. It has been estimated that 80% of the heat and steam produced is used for institutional purposes. The remaining 20% is used for research purposes including the wind tunnels, test cells, and other activities.

A15 SPECIAL LAND USES IN THE VICINITY OF THE CENTER

A15.a Special Land Uses

Lewis Field is situated in an urbanized area. It is bounded to the east by Cleveland Hopkins International Airport (CHIA). The majority of the land use in the area surrounding the airport consists of residential development. In addition, mixed concentrations of commercial and industrial development occur to the east and northeast and sporadically throughout the area.

To the south it is bounded by Aerospace Tech Park, a commercial development, and CHIA. One residential area is situated adjacent to the southwest corner of Lewis Field. Parking lots border the north-north east area of Lewis Field.

The majority of the land west and north of Lewis Field is owned by Cleveland Metroparks. Cleveland Metroparks is a multi-county, locally owned and managed political subdivision of the state of Ohio. The Park District is governed by Cleveland Metroparks Board of Park Commissioners, composed of three citizens who serve three-year terms without compensation. Lewis Field is bordered in this area by the Rocky River and its tributary, Abram Creek. The Rocky River Reservation is one of the largest Cleveland Metroparks reservations, with over 3,400 acres in the communities of Lakewood, Rocky River, Fairview Park, Cleveland, North Olmsted, Olmsted Township, and Berea. The Rocky River has not been designated as wild or scenic, but it is a wildlife refuge in its capacity as a Metroparks reservation.

There are no national seashores, wild or scenic rivers, national or state parks, or hospitals in the immediate vicinity of the center. The nearest hospital, Fairview, is approximately four miles north of Lewis Field.

PART B – GLENN RESEARCH CENTER AT PLUM BROOK STATION

B1 DESCRIPTION OF PLUM BROOK STATION

B1.a Description of the Center

The Plum Brook Station (PBS) is operated as a satellite facility (component installation) of the NASA Glenn Research Center. Use of this site by the Federal Government began in 1941 when the U.S. Army established the Plum Brook Ordnance Works for the manufacture of munitions. Munitions production took place from 1941 to 1945, after which buildings and production lines were decontaminated and decommissioned. There were then several changes in ownership and eventual transfer of portions of the site to NACA (later NASA) in 1955. To develop the Station in 1958, NASA gained ownership of approximately one-third of the Plum Brook Ordnance Works (PBOW). PBOW was constructed by the War Department between 1938 and 1941. PBOW consisted of 3,646 hectares (9,009 acres) inland, 0.5 hectares (1.35 acres) for 2 pumping stations on Lake Erie and approximately 700 buildings. Between 1958 and 1960, NASA demolished hundreds of buildings, renovated approximately 41 buildings, and utilized 99 magazines. Currently only four facilities are capable of performing research.

NACA's original interest in the site was as a testing location for high-energy rocket engines and nuclear power systems. Other activities at PBS over the years have included the development of special pumps for space applications, rocket engine research, space vehicle testing, cryogenic testing, wind tunnel testing, and related aerospace research.

The NASA portion of the PBS site is 2,614 hectares (6,454 acres) in size. The site is located in a rural area in west central Erie County, Ohio, approximately 80 kilometers (50 miles) west of the Lewis Field in Cleveland. The nearest city is Sandusky, 6 kilometers (4 miles) to the north. Most of the PBS site is in Perkins and Oxford townships, with some land in Huron and Milan townships to the east. The site boundaries are Bogart Road to the north, Mason Road to the south, U.S. Highway 250 to the east, and County Road 43 to the west (Figures B1-1 and B1-2, found at the end of this section).

The northernmost point is at latitude 41°23'39"N; and the southernmost point at 41°20'04"N. The westernmost point is at longitude 82°43'12"W; and the easternmost point is at 82°38'39"W. The location can be found on the USGS 7.5 minute-series topographic maps for the Kimball and Sandusky Quadrangles (N4115-W8237.5/7.5 and 41082-D6-TF-024, respectively).

B1.b GRC Plum Brook Station Facilities

The 2002 Real Property Report (GRC, November 2002) lists 179 buildings, structures, and other entities at PBS. These include offices, mechanical and process equipment areas, test facilities, substations, warehouses and wastewater treatment facilities. The capital cost of PBS facilities is given as $110 million, with a replacement cost of $711 million. The total gross square area (measured from outside wall to outside wall) is 84,814 square meters (912,927 square feet). The Facilities Utilization Report (GRC, November 2002) states the "allocated net useable area" at approximately 71,603 square meters (770,731 square feet). The largest percentages of this space are devoted to storage (34%), miscellaneous (27%), technical/laboratory facilities (19%), shop/industrial (13%) and office space (6%).

The PBS was placed on standby status in 1974. Some site facilities were preserved for future use and in 1987 were made available to government and commercial users on a full-cost reimbursable basis. This included four major space-testing facilities, as described below.

The four active facilities are categorized as three types. The Spacecraft Propulsion Research Facility (B-2) and the Space Power Facility (SPF) are considered Space Flight Systems Facilities. Hypersonic Tunnel Facility (HTF) is an Aeronautical Research Facility, while K-Site is an Aerospace Technology Facility. The locations of these facilities are depicted in Figures B1-1 and B1-2.

Space Power Facility (SPF): Facility Description

SPF was built for nuclear work including testing nuclear rocket engines and nuclear power supplies. However, SPF was never used for that type of research; instead it was utilized to test launch vehicle shroud separation tests including the Centaur, Skylab, and Viking programs. The facility was designed to allow for the testing of space power generation systems under simulated space environmental conditions. SPF is the largest nuclear-rated, controlled-environment test chamber in the world. The test chamber is 30.5m (100 ft.) in diameter by 37.2m (122 ft.) high with 22,653 cubic meters (800,000 cubic feet) of usable unobstructed volume. The facility can fully simulate the space vacuum, temperature and solar environment for various test configurations. The facility was activated in 1986 for research programs needing nuclear capability, as well as a wide range of pressures including hard vacuum. It also was used for research programs with temperatures ranging from outer space to atmospheric ascent condition. Other configurations included controlled gas composition, or programs having specialized needs, such as a large surrounding clear zone area, large volume, solar simulation, and contamination simulation or control.

Most of the world's large payload fairings have been tested in the SPF. These include fairings for the Atlas-Centaur, Titan IV, and Ariane IV and V. More recently, the fairings were tested for both of the newly developed Evolved Expendable Launch Vehicles. The Delta IV fairing was tested for the Boeing Company and the Atlas V fairing was tested for the Lockheed Martin Company. From 1996 to 1999 a significant amount of testing was performed in the SPF for the International Space Station. The large deployable radiators for the heat rejection system and the photovoltaic power system were tested. These tests were evaluating the radiator system and its deployment mechanism, qualification thermal cycling and thermal heat rejection performance. After this series of tests were performed, the radiator systems were launched and installed on the International Space Station.

Other testing performed at the SPF includes deep drop testing of the lander system for the Mars Pathfinder Mission and the Mars Exploration Rover (MER) Mission. Similar testing was also done for the European Space Agency's Beagle 2 Mars Mission. SPF was recently selected to conduct ground based testing of the James Webb Space Telescope. This multiyear program is scheduled to begin in 2006.

Spacecraft Propulsion Research Facility (B-2): Facility Description

The Spacecraft Propulsion Research Facility (B-2 Facility) is used for research, development, and validation testing of spacecraft and space propulsion systems. It is the world's only space environment chamber that can perform full-mission profile simulation testing for large upper stage rocket engines and complete launch vehicles. The facility can simulate vacuum, cryogenic background temperatures, and solar heating conditions found in near-earth orbit. Systems can be subjected to long-term conditions of cold, vacuum, and solar heating. The facility includes a large vacuum chamber; a "cold wall" using liquid nitrogen coolant; and radiant heating for solar thermal simulation using quartz infrared lamps. Liquid oxygen-liquid hydrogen rocket engines can be fired for up to six minutes. Vehicle engines producing up to 1,779 kilonewtons (400,000-lb) of thrust can be fired for either single or multiple burn missions, utilizing either cyrogenic or storable fuels or oxidizers. Engine exhaust conditions can be controlled to simulate a launch ascent profile. In

addition, conditions can be maintained before, during, and after the test firing. A test rocket can be installed vertically and fire its engines into a water-cooled diffuser and spray chamber containing 6.62 million liters (1.75 million gallons) of chilled water. This water is contained and can be treated later if contaminated by the rocket exhaust. During a typical test program, the test article is installed within the B-2 vacuum chamber and the necessary electrical power, fuel, oxidizer, and purge gas connections are made. The low-pressure, temperature-controlled flight environment is established to thermally condition the hardware and propellants prior to engine firing. B-2 offers a complete "test-as-you-fly" environment to thoroughly ground test flight hardware and reduce the likelihood of costly flight failures. In 1998, tests of the Boeing Delta III cryogenic upperstage were successfully conducted in the B-2 facility.

Other test programs include Space Electronically Agile Radar (SPEAR) I Flight Hardware Test (1987), SPEAR III Mock Up Tests (1992), and SPEAR III Flight Hardware Tests (1992). SPEAR was a high voltage power supply system. SPEAR is an instrument used to trace the energy flow in the gas between stars. The project would form a critical part of the Korea Advanced Institute of Science & Technology Satellite (KAISTSAT-4) mission. The SPEAR spectrograph would observe million-degree gas in the interstellar medium of our Galaxy in order to identify the sources of the thermal energy and determine how this energy is transported through the gas.

Cryogenic Propellant Tank Facility (K-Site): Facility Description

The Cryogenic Propellant Tank Research Facility (K-Site) performs testing of a variety of rocket propellant tank systems. These include cryogenic fluid slush tests, tank fill and expulsion tests, and performance testing of tank insulation systems. Boundary conditions, from ground hold to deep space, can be controlled utilizing a heated or cooled shroud enclosing the test package in a vacuum chamber. The facility includes a 7.6 meter (25 ft) diameter test chamber with a volume of 269 cubic meters (9500 cubic feet). Propellant types which can be tested include liquid hydrogen, liquid nitrogen, gaseous hydrogen, gaseous nitrogen, and gaseous helium. According to the Facilities Utilization Report the K-Site continues to be used intermittently for densified hydrogen research programs for advanced engine development. In 2003 the Cryogenics Components Laboratory will be relocated to PBS from Lewis Field and become part of the K-Site Complex.

Hypersonic Tunnel Facility (HTF): Facility Description

The Hypersonic Tunnel Facility, HTF, has the distinction of being the largest ‘clean air’ hypersonic tunnel facility in the United States. The HTF site embodies a large ‘stand-alone’ experimental infrastructure that can be readily reconfigured to address a host of ground test applications. It has a generous exclusion zone that allows for high energy, high risk testing.

Originally designed and built in 1966 to test nuclear thermal rocket nozzles as part of the NERVA program, it was reconfigured in 1969 as a hypersonic free-jet facility capable of testing large scale hypersonic airbreathing propulsion systems. Three interchangeable nozzles are used to provide air at velocities of 5, 6 and 7 times the speed of sound at temperatures in excess of 1,871 degrees Celsius (3,400 degrees Fahrenheit). At the heart of the facility lies a 3 megawatt (MW) graphite storage heater capable of containing nearly 14 million kilojoules (130 million BTUs). A single stage ejector flowing 227 kilograms (500 pounds) per second of steam is used to provide altitude simulation up to 27,432 meters (90,000 feet). Upon completion of approximately 70 test runs for the Hypersonic Research Engine Program the facility was put in standby status in 1974.

In 1985 a study was performed to address the requirements to rehabilitate the HTF. In 1993 this work was completed and the HTF was reactivated to support NASA’s generic hypersonic propulsion research efforts. Testing of a Rocket Based Combined Cycle (RBCC) Engine began in 1996. The RBCC was conceived as one way of providing propulsion for a single stage to orbit vehicle. Such a vehicle would provide cheaper, more

efficient (reusable) access to space. Forty six (46) test runs were completed at Mach numbers of 6 and 7 (simulated enthalpies) in support of the RBCC test program. In 1998 the graphite storage heater was completely rehabilitated to 'like new' status as was the facility controls architecture. A subsequent Integrated Systems Test (2000) provided evidence of a successful return to service of the improved facility.

The Hypersonic Tunnel Facility (HTF) was once a heat transfer facility and later converted to support the development of air-breathing engines suitable for use in hypersonic aircraft. The HTF can provide true aero-thermodynamic simulation of the flight environment. It can test propulsion systems and components with synthetic air at speeds up to Mach 7 (approximately 8,700 kph [5,400 mph]). Models up to 0.6 meters (2 feet) in diameter and 3 meters (10 feet) in length can be tested. The facility includes storage of approximately 20,000 cubic meters (700,000 cubic feet) of gaseous nitrogen and a smaller quantity of gaseous oxygen which are used to create the desired atmospheric test conditions.

B1.c Other Facilities

The Plum Brook Reactor Facility (PBRF) began operation in the early 1960's. After approximately ten years of operation, the facility was shut down. In 1979 NASA determined there was no further need for this facility and it could be removed. Funding limitations have prohibited dismantling and decommissioning to date (see Chapter B11). The Reactor was placed in safe storage and, in 1999, NASA applied to the NRC for a decommissioning license. The license was received in March of 2002 and decommissioning efforts are currently ongoing with license termination targeted for 2007.

Other facilities at PBS include the Engineering Building (Building 7141) which provides office space. There are 99 storage bunkers (originally used for storing munitions) in the southeast area, nearly all of which are now used for warehousing and storage of records and chemical supplies. The Ohio Air National Guard stores munitions in one bunker. Two raw water pumping stations are located off-site and supply water for fire protection and cooling equipment. There is also a small airstrip, as well as buildings for mechanical and process equipment, shipping and receiving areas, substations, and cooling towers.

B1.d Plum Brook Station Tenant Agencies

Plum Brook tenants currently include the following agencies:

- Department of Agriculture (APHIS, Wildlife Services, Airport Research)
- Department of Interior (Fisheries Research, Sandusky Biological Station, Law Enforcement)
- Federal Bureau of Investigation
- U.S. Coast Guard

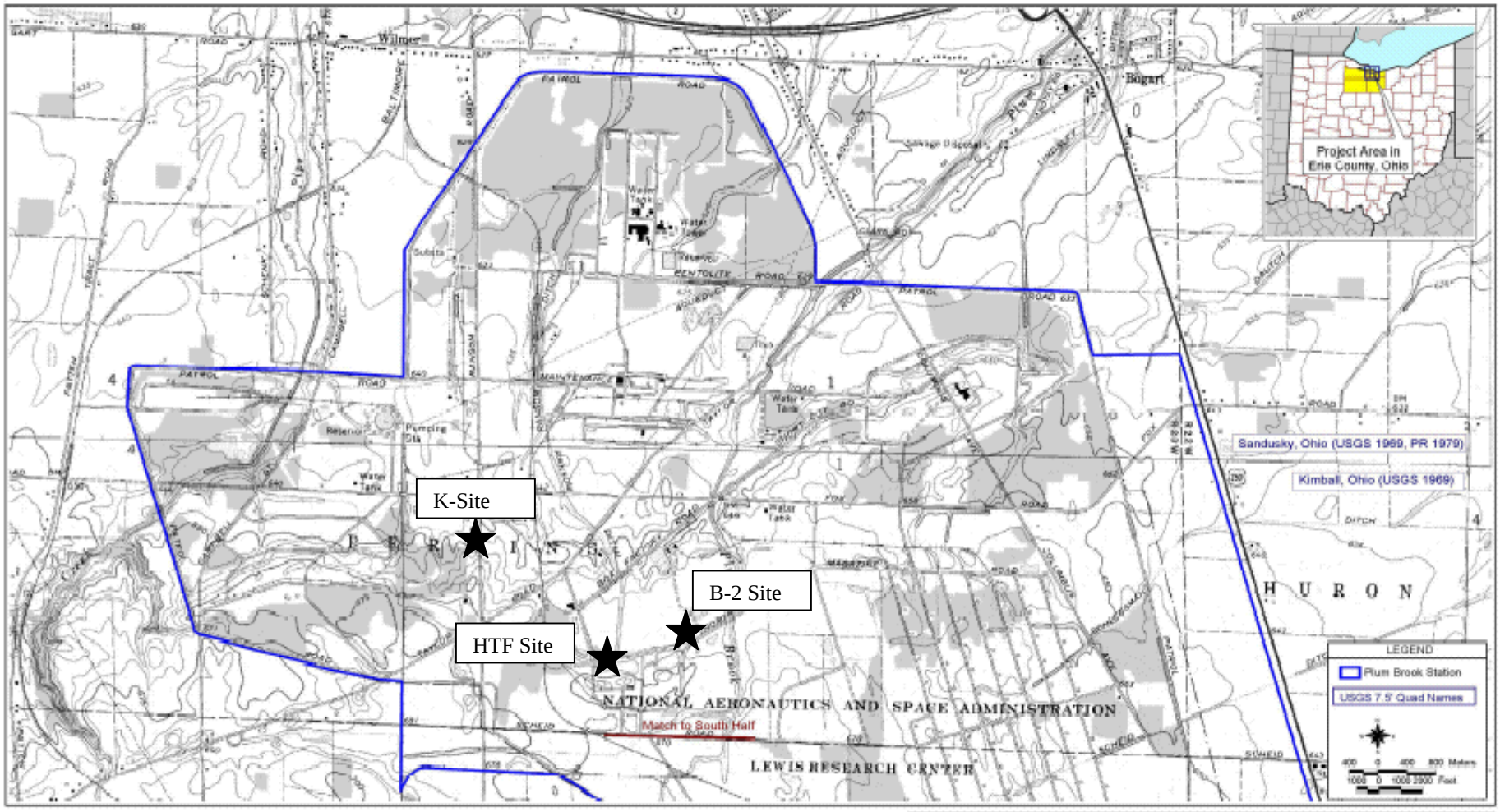


Figure B1-1
Map of the Northern Half of Plum Brook Station

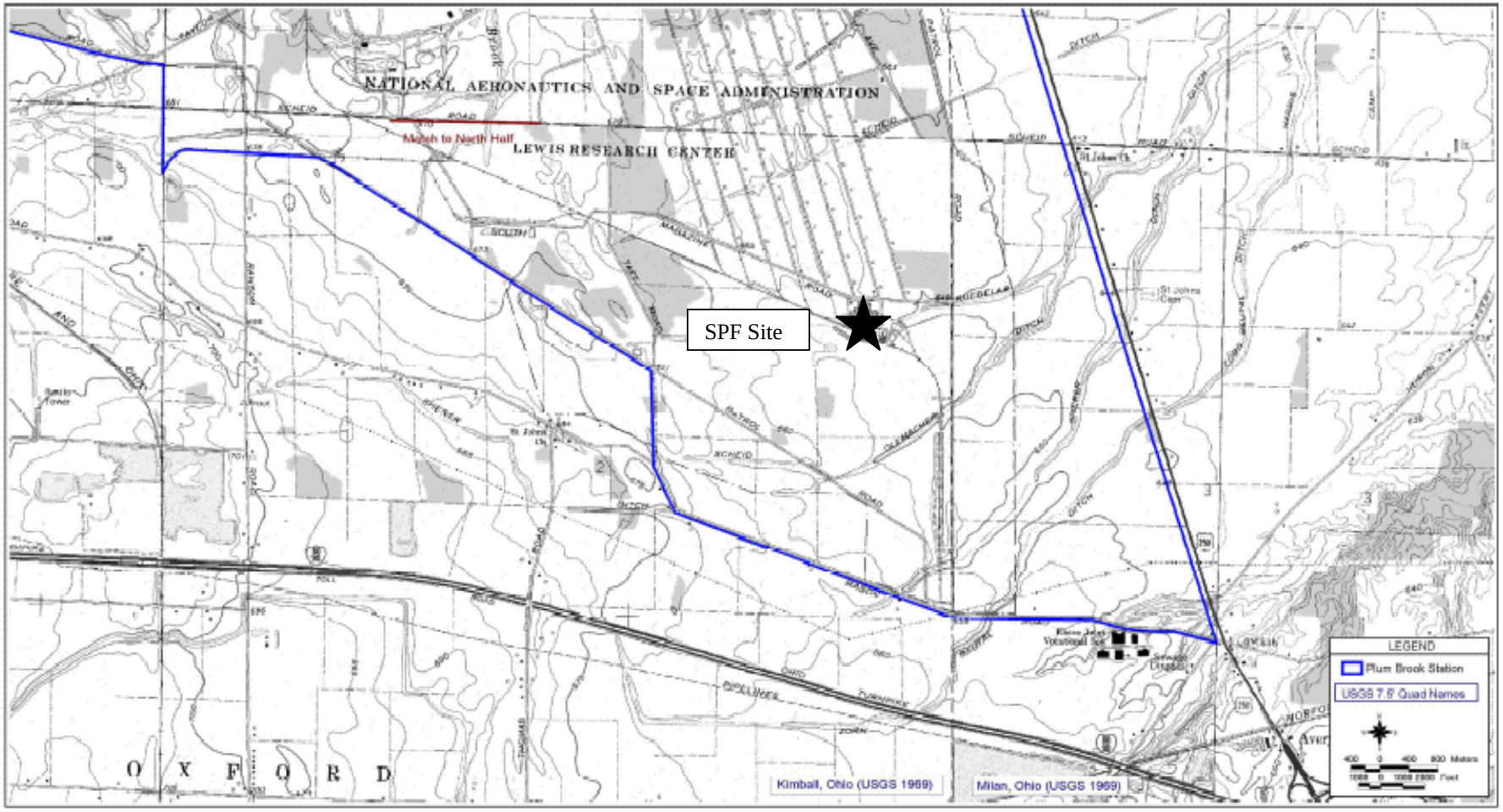


Figure B1-2
Map of the Southern Half of Plum Brook Station

B2 AIR RESOURES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to air pollution and its control. Relevant chapters include:

- Chapter 4 Air Pollution Control
- Chapter 26 Ozone Depleting Chemicals

B2.a Climate

At PBS the climate is continental in character and influenced by proximity to Lake Erie. Summers are moderately warm and humid, with temperatures occasionally exceeding 32ºC (90º F). Winters are cold and cloudy, with temperatures falling below -18º C (0º F) an average of five days per year. Annual temperature extremes typically occur after late June and in January. First frost typically occurs in October.

Average annual precipitation is 114.3 centimeters (45 in). The 2-year, 24-hour rain event is 6.2 centimeters (2.45 in). Average annual water loss is estimated at 57 centimeters (22.5 in). The National Weather Service maintains a volunteer Cooperative Data Station in Sandusky (Data Station Index Number 7447). Daily high and low temperatures and precipitation data are published in a Cooperative Data Report for this location. More detailed climatological data for Plum Brook Station can be obtained from the National Weather Service.

The predominant wind direction is southwest throughout the year. In spring and summer, there are also northerly and northeasterly breezes from the lake (Morrison Knudsen Corporation, 1994).

B2.b Local Air Quality

The Ohio EPA North West District Office conducts air monitoring for the district including Erie County which tracks carbon monoxide, nitrogen oxide, nitrogen dioxide, sulfur dioxide, particulate matter (PM-10), total suspended particulates, ozone, and toxic air pollutants. As of this writing, Erie County is designated as an attainment area. The National Ambient Air Quality Standards are listed in Table A2-1. Current information may be obtained from the Ohio Environmental Protection Agency. Information may be located on-line at the following web sites: http://www.epa.state.oh.us/dapc/ams/airtox.html, http://www.epa.state.oh.us/dapc/ams/amsmain.html, or http://www.epa.gov/airs/criteria.html).

B2.c Stationary Sources

Plum Brook Station has an assigned Ohio EPA air program facility identification number, 0322020172. The NAICS Code is the same as Lewis Field (see chapter A2). Stationary on-site emission sources include boilers, heaters, research test cells, a degreaser and many additional insignificant and trivial sources. The boilers represent the largest actual emission source at Plum Brook Station. Table B2-1 lists the stationary sources used in emission calculations. The two permitted boilers are scheduled for replacement in the fall of 2003. After the installation of the replacement boilers, the annual emissions rate should remain the same or decrease.

As of this writing, the Plum Brook Station facility is classified as a minor source under Title III and Title V of the CAAA and is registered under the Ohio EPA Non-Title V Emission Fee (Blue Card) Program in conjunction with a Presumed Inherent Physical Limitation (the inability to discharge air pollutants in quantities that trigger Title V requirements). Accordingly, Plum Brook Station prepares and submits bi-

annual actual emission reports based on actual natural gas consumption for the year. Plum Brook Station has only one applicable National Emission Standards for Hazardous Air Pollutant regulation for degreasing operations. The sources for this report are listed in Table B2-1.

Table B2-1 Stationary Sources Used for Bi-Annual Emissions Report

Source	Building Number	Permit Status
Heating Boiler #1	1411	Registered
Heating Boiler #2	1411	Registered
Heating Boiler #3	1411	Registered
Heating Boiler #1	2831	Registered
Heating Boiler #2	2831	Registered
Heating Boiler #1	3232	Registered
Heating Boiler #1	3431	Registered
Halogenated Degreaser	1491	PTI

Table B2-2 lists solvent use in degreasers at PBS. The Facility holds the appropriate air permit for this operation which will be updated to an Area Source Title V Permit application when this category of permit application becomes due. In the interim, Plum Brook Station is investigating the possibility of a process modification and reclassification away from this permitting need. At this time there are no listed toxic, flammable or explosive substances in excess of the threshold quantities requiring a Risk Management Plan.

Table B2-2 Solvent Use in Degreasers at PBS

Solvent	Composition	Estimated Annual Use
Varsol	Paraffins 55% Napthenes 40% Aromatics 5%	76 liters (20 gallons) (Building 1411, 7131)
Super Agitine	Paraffins-napthenes 98% Dipropylene glycol methyl ether <0.5%	114 liters (30 gallons) (Building 7131)
Phosphoric acid, Isopropyl alcohol, or TCA		1249 liters (330 gallons), starting in 1996 (Building 1491, 3 units)
Super Agitine		76 liters (20 gallons) (Bldg 3131)

Estimated actual emissions, based on the averaged bi-annual Emission Fee Reports from 1994 to 2001, are: 0.138 metric tons (0.153 tons) of particulates, 0.011 metric tons (0.012 tons) of sulfur dioxide, 1.70 metric tons (1.873 tons) of nitrogen oxides, .101 metric tons (0.111 tons) of organic compounds, and 1.54 metric tons (1.696 tons) of carbon monoxide annually. The relatively low actual annual emission rates are a result of the nature of research. In this industrial classification, analytical data or "research" is the product and, as such, it is not like manufacturing or mass production. Since each experiment is configured individually, the equipment cannot operate 8,760 potential hours per year. In general the areas with the highest potential to emit take the longest to prepare to operate. In some cases the preparation time may take months with the projects being planned years in advance. These low actual emission rates allow Plum Brook Station to be granted permitting flexibility under a Presumed Inherent Physical Limitation.

Bulk storage tanks at PBS contain gasoline and diesel fuel. Building 7143 contains laboratory fume hoods used during chemical analyses of water samples. Of the internal combustion engines on site, the two largest are a 536,904 kilojoules (200 horsepower) backup pump in Building 8133 and a 1.25 megawatt electric generator set in Building 1411. Open burning is practiced for vegetation control and is an additional source of emissions. An on-site incinerator has not been used for more than 20 years.

Due to its limited emissions, the PBS is not classified as a major source under the Clean Air Act Title V permitting program. PBS has applied for and received PTIs and PTOs for various on-site air emission sources. An environmental audit (Foster Wheeler, 1996) found PBS to be in general compliance with air regulations. The Environmental Justice Implementation Plan (Jones, 1996) concluded there was "...no reasonable likelihood of substantial off-site air quality impacts from normal operations and only moderate likelihood of substantial off-site air quality impacts from emergency operations or reasonably foreseeable accidents."

B2.d Mobile and Off-Site Sources

On-site vehicles are classified as mobile sources of emissions. Plum Brook Station vehicles include construction & other heavy vehicles & fleet vehicles. Many of the vehicles operate on natural gas or duel fuels. As of this writing, a bio-diesel program is in the prototype phase. Other air emissions are not generated by Plum Brook Station directly but are attributable to its operations. These types of emissions would include power plant emissions for PBS's electrical power needs, off-site research activities and the use of private, commercial and fleet vehicles for business related transportation.

B2.e Ozone-Depleting Substances

NASA Headquarters and GRC at Lewis Field and PBS have established ODS management policies and plan to eliminate the use of these chemicals in all but critical applications. Chapter 26 of the GRC Environmental Programs Manual addresses the ODS policy. All ODS are controlled substances at PBS and require special approval before they may be purchased. Larger equipment containing or processes using ODS chemicals are monitored and their chemical use is tracked. New refrigeration equipment must be ODS-free whenever possible. Additionally, Executive Order 12843 (1993), *Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances*, and Executive Order 13148 (2000) *Greening the Government Through Leadership in Environmental Management* direct Federal agencies to use alternative chemicals to the extent possible. Plum Brook Station continues to use ODS chemicals however, with the current policy, the use of these materials is declining.

B3 WATER RESOURCES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to water pollution control. Relevant chapters include:

- Chapter 3 Water Pollution Control

B3.a Surface Water Hydrology

Plum Brook Station is located in the Lake Erie watershed. The Huron River and its branches constitute the major surface water system (Figure B3-1). Eleven streams cross the site, the largest of which are Pipe Creek, Kuebler Ditch, Ransom Brook, and Plum Brook. Streams generally flow northward and converge into Ransom Brook, Storrs Ditch, Plum Brook, and Sawmill Creek and eventually flow into Lake Erie. The drainage areas of streams at PBS are shown in Figure B3-2. The streams could receive some of their volume from groundwater. Seventeen isolated ponds and reservoirs and three red water ponds are also located on the PBS site (SAIC, June 1991). There are no catch basins specifically intended to collect runoff.

The largest surface water body near PBS is Sandusky Bay on Lake Erie, approximately 6 kilometers (4 miles) to the north. Lake Erie is one of the five Great Lakes and has a surface area of approximately 25,700 square kilometers (9,919 square miles) and an estimated volume of 471 cubic kilometers (113 cubic miles) (SAIC, June 1991). Most commercial fishing takes place near Sandusky Bay. Lake Erie is also a popular recreational resource for boating and beaches. Other surface water features include Bellevue Reservoir Number 5 which is 23 kilometers (14 miles) to the south-southwest. There are numerous other ponds and streams within a 24 kilometer (15 mile) radius. The Erie County Health Department does not permit surface water to be used for private drinking water supply.

B3.b Surface Water Quality

All surface waters at PBS are classified as Warmwater Habitat by the Ohio EPA. Other use designations applicable to PBS streams include Primary Contact Recreation (swimming) and Agricultural and Industrial Water Supply. Ohio EPA does not routinely monitor the streams which drain the PBS site. The only known ambient monitoring data from the area were taken in Pipe Creek (upstream of PBS) in 1984. While monitoring data are limited, water quality in the streams that originate or flow through PBS is believed to be generally good. Hemming Ditch and Plum Brook ultimately discharge to Lake Erie within the Sheldon Marsh State Nature Preserve, and are afforded special protection by ODNR.

PBS has two surface water areas which were believed to be affected by earlier manufacturing operations. Both are former wastewater disposal areas utilized between 1941 and 1945 during the manufacture of TNT. The water in these ponds is sometimes characterized by a reddish brown tint which explains the moniker “Red Water Ponds”. One area is located near Pentolite Road and drains to Plum Brook. This area is designated as the Pentolite Road Red Water Pond and is in the process of remediation by the U.S Army Corps of Engineers (USACE) as part of the clean-up of the former Plum Brook Ordnance Works. The other area contains two separate ponds labeled the West Area Red Water Ponds which cover approximately 3 hectares (8 acres) in the western area of PBS south of Fox Road. Drainage from these ponds enters Pipe Creek, particularly when there is significant precipitation. A recent baseline Ecological Risk Assessment (IT Corporation, November 2001) determined that further remediation at the West Area Red Water Ponds was not recommended.

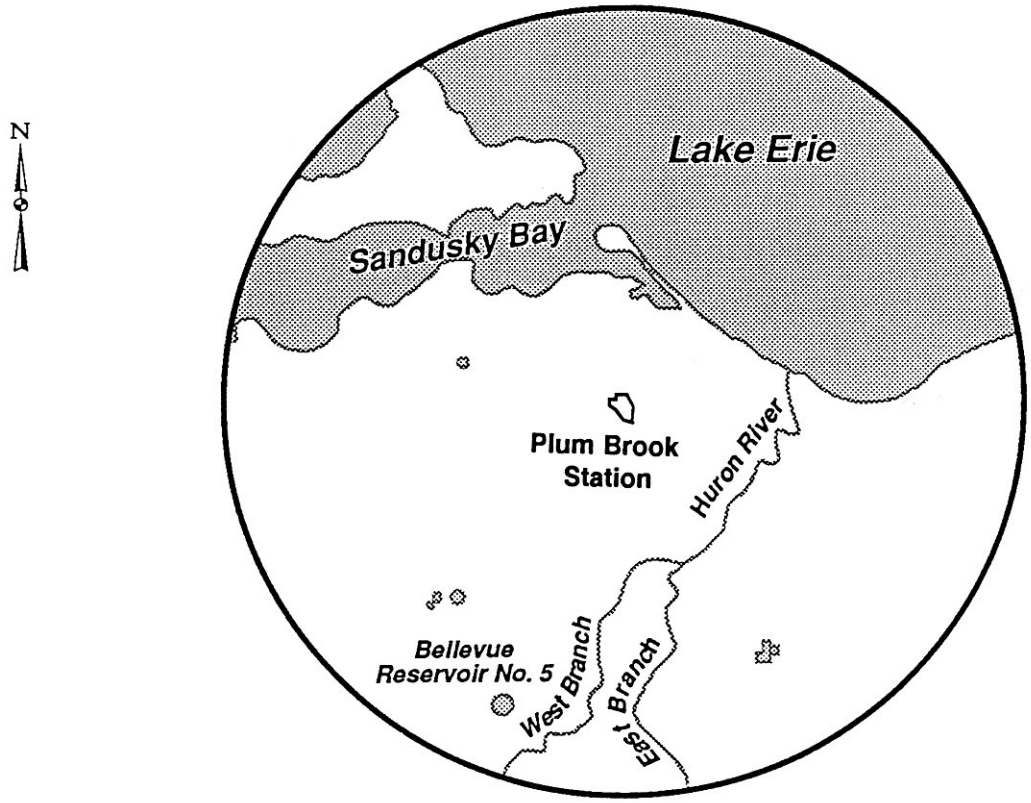


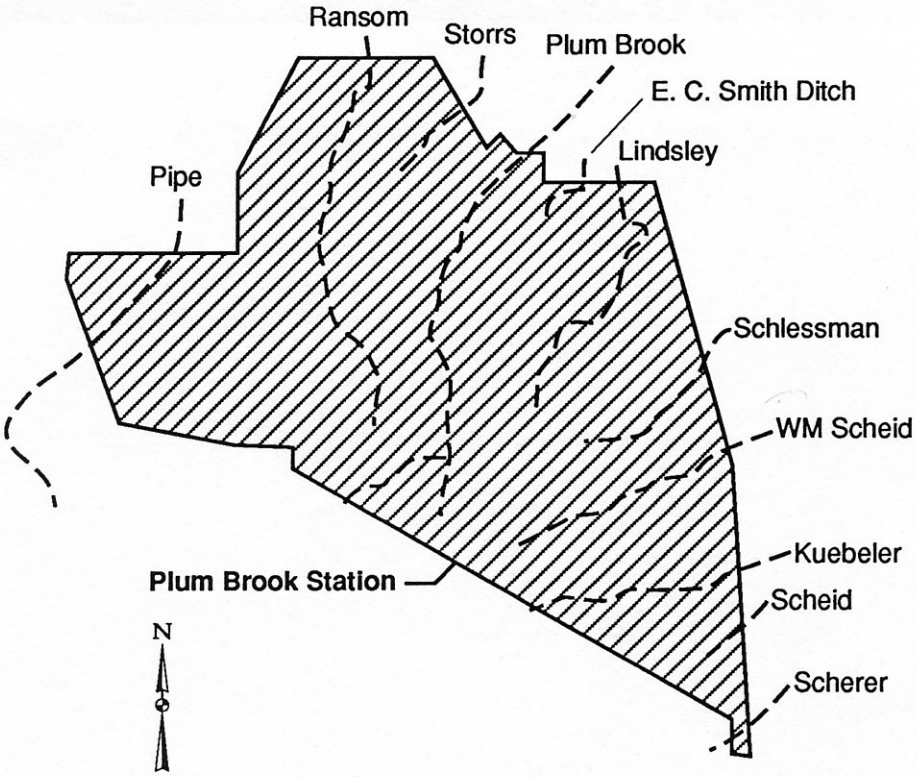
Figure B3-1 Surface Water Resources in the Vicinity of PBS

B3.c Groundwater

The majority of residents of Erie County receive water from public utilities that obtain most of their water from surface water sources. Residences to the north and east of PBS are connected to city, county or rural services. Erie County's primary groundwater source is from the limestone and dolomite aquifer found in the western end of the county. This aquifer also underlies portions of PBS.

Groundwater wells in the central and eastern portions of the county tap lower-yielding shale and sandy zones in the overburden. Some wells surrounding PBS are used for agricultural purposes, including irrigation, which could have an effect on drawdown near the site. A few wells in the vicinity of PBS were determined to be used for private and public consumption; however, none within the facility boundary are used. The distance between private wells and site wells is not known.

Regional groundwater flow is to the north-northwest towards Lake Erie, although local flow may vary due to local topography. Water in the limestone typically occurs in joints and along bedding planes or in solutionally enlarged openings. Although some limestones in the middle of the county provides well yields up to 1,893 liters (500 gallons) per minute, the overburden and the majority of the other formations can sustain groundwater pumping of only 38 lpm (10 gpm) or less. A hydrogeological study by the USGS conducted on the glacial deposits in Sandusky in 1990 reported a horizontal hydraulic conductivity of 0.046 cm/day (0.046 ft/day) and a vertical hydraulic conductivity of 37 cm/day (1.2 ft/day).



Stream	Drainage Areas in Acres	
	Entering	*Leaving*
Pipe Creek	11,800	12,600
Ransom Brook	*	824
Storrs-Hemminger Ditch	*	130
Plum Brook	260	1,960
E.C. Smith Ditch	*	44
Lindsley Ditch	*	722
Schlessman Ditch	*	238
William Scheid Ditch	*	505
Kuebeler Ditch	148	658
Scheid-Ohlemacher Ditch	40	273
Scherer Ditch	754	778

PBF-01

* Stream originates within station boundaries.

Surface drainage watershed boundaries

Figure B3-2 Surface Streams at PBS

At PBS, the groundwater has been divided into three zones based on location and yield. (Figure B3-3) Zone one occurs in the north and northwestern portion of the Station. It has been characterized as yielding from 379 to 1,893 liters (100 to 500 gpm) from karstic limestone approximately 30 meters (100 feet) below grade. Zone two is in the northern portion of PBS and has yields of 57 lpm (15 gpm) or less from limestone approximately 91 meters (300 feet) below grade. Zone three is located in the eastern and southern portion of the site in predominantly shale bedrock. In addition to being found in the shale, groundwater is located in thin sand and gravel horizons interbedded with silt and clay deposits. Most zone three wells are poor yielding, many of them providing less than 11 lpd (3 gpd).

The two main water-bearing zones at PBS are the overburden and the bedrock. Data from recent groundwater investigations conducted by the USACE, related to the contamination from munitions manufacturing at the former PBOW, have found that groundwater in the overburden is in discontinuous pockets during dry time periods. During these periods of low precipitation, only limited migration of contaminants occurs due to less infiltration. During a wet period, the general flow direction in the overburden water-bearing zone is to the north-northeast largely mirroring surface topography. The flow also corresponds somewhat to the topography of the top of the bedrock. In contrast the bedrock water-bearing zone is saturated year round. The conceptual model of the site is that groundwater flow in the bedrock zone migrates and is influenced by the frequency, orientation, density and connectivity of the fractures. Similar to the overburden flow direction, groundwater in the bedrock flows north-northwest. (USACE, PBOW 2002 GW Data Summary and Evaluation Report)

No groundwater at PBS is used for drinking water. There are no injection wells on site. Therefore, routine groundwater monitoring is not required. Groundwater investigations are being conducted by the USACE in connection with site remediation activities such as the red water ponds. Approximately 83 monitoring wells have been installed. Ongoing groundwater investigations have found several contaminants including nitroaromatics, VOCs, SVOCs, and metals. This contamination will be remediated, but results to date do not indicate that immediate or emergency action is required.

B3.d Wastewater Discharges

Wastewater discharges at PBS include stormwater, non-contact cooling water, cooling tower and boiler blowdown, and sanitary discharges. There are currently no significant sources of process wastewater. All PBS package waste water treatment plants have been routed to the Erie County Sewage Treatment Works with the exception of the SPF WWTP (outfall #005).

Surface discharges are authorized by NPDES Permit No. OH 2IO00002*D, effective February 1, 2002 through January 31, 2007. The permit covers nine discharge locations including two in-stream monitoring stations, one sewage treatment plant outfall, two retention ponds, three non-contact cooling water outfalls and one UST remediation monitoring station. One station (#015) is reported as no flow since the discharge has been routed to the sanitary system. Permit limitations and monitoring requirements are shown in Table B3-1. PBS is in compliance with its NPDES permit (Foster Wheeler, 1996).

Stormwater from developed areas is collected in sumps and discharged through permitted outfalls which may contain stormwater, non-contact cooling water, or a mixture of both. Other stormwater is discharged to the ground or to streams. Stormwater can amount to hundreds of thousands of gallons during a major rainfall event.

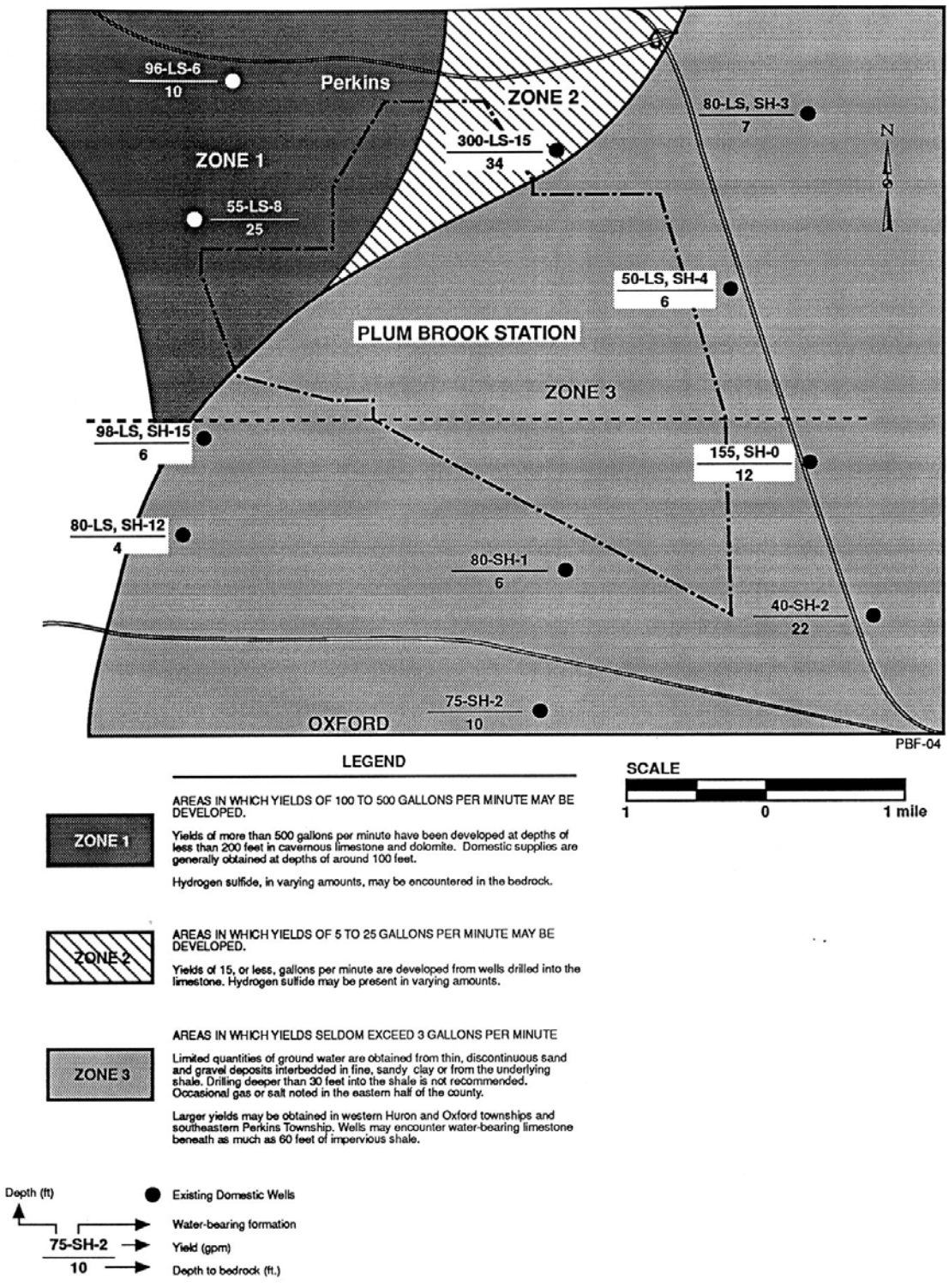


Figure B3-3 Water Bearing Zones at PBS

The Environmental Justice Implementation Plan (Jones, 1996) concluded there was "...no reasonable likelihood of substantial off-site water quality impacts from normal operations and only moderate likelihood of substantial off-site water quality impacts from emergency operations or reasonably foreseeable accidents... Review of solid and hazardous waste programs indicates no reasonable likelihood of significant impacts to water quality from present actions and programs and only moderate impacts to water quality from earlier munitions manufacturing activities at the [Plum Brook] Station."

B3.e Water Use and Supply

Potable water used at PBS is purchased from the Erie County Water Division. The Division uses Lake Erie as its source of public, commercial, and industrial water supply. Water for PBS is drawn at the Big Island Pump Station and rechlorinated at PBS as a means to assure adequate disinfection. Neither local surface water nor wells are used for drinking water. Monthly monitoring is conducted for chlorine and coliform bacteria. Annual monitoring is conducted for turbidity, pH, lead, iron, copper, and zinc. Annual volume utilized by PBS is over 60.2 million liters (15.9 million gallons).

Drinking water fountains and janitorial sinks are tested for Safe Drinking Water Act parameters every six months. Analytes include free chlorine, chromium, coliform bacteria, copper, iron, lead, pH, and zinc. No drinking water fountains on site contain a lead liner.

Prior to obtaining drinking water from the Erie County Water Division, PBS pumped and treated water from two pumping stations it owns on the shore of Lake Erie. These facilities were developed during the operation of the PBOW and are no longer used for potable water.

Table B3-1 – Summary of PBS NPDES Monitoring Requirements

[a] Monitoring requirements: D – Daily; T – Every two weeks; W – Weekly; M – Monthly; Q – Quarterly

Outfall Number Under NPDES Permit #2IO00002*ID										Parameter (Units)	Discharge Limitations				Monitoring Frequency[a]
001	002	003	005	009	010	013	014	016	588		Max/Min	Weekly	Monthly	Daily	
√	√	√		√	√	√	√	√		pH (S.U.)	6.5-9.0				M
	√			√	√	√		√		Temp (°C)	Monitor				M
			√							Temp (°C)	Monitor				W
		√		√	√	√		√		Flow MGPD)	24 Hr Estimate				M
			√							Flow MGPD)	24 Hr Estimate				D
							√			Flow(GPD)	24 Hr Estimate				M
√	√						√			COD (mg/l)	Monitor				M
		√								COD (mg/l)	Monitor				Q
√							√			Oil & Grease (mg/l)	10 Max				M
	√	√								Oil & Grease (mg/l)	10 Max				Q
√	√	√								Hardness (mg/l)	Monitor				Q
√	√	√								Metals (µg/l)	Monitor				Q
√										Chlorine (mg/l)	Monitor				M (Summer)
			√							Chlorine (mg/l)	0.019 Max				T
		√								TSS (mg/l)	Monitor				Q
			√							TSS(mg/l)		45	30		M
			√							Nitrogen, Ammonia (NH3) (mg/l)		3	2		M
			√							Odor, turbidity, color (severity units)	Monitor				D
			√							Fecal Coliform (#/100ml)		2000	1000		M
			√							CBOD (mg/l)		40	25		M
			√							Dissolved O2 (mg/l)	5.0 Min				W
							√			Lead (µg/l)	5.0 Max				M
							√			PAH's (µg/l)	5.0 Max				Q
							√			BTEX (µg/l)	5.0 Max				M
									√	Sludge (Tons)	5.0 Max				M

B4 LAND RESOURCES

B4.a Topography

PBS is situated on land which was once lake bottom formed from glacial melt waters. The site is relatively flat and slopes gently northward. The average slope of the land is less than six percent. Elevations range from about 191 to 207 meters (625 to 680 feet) above sea level.

B4.b Geology and Soils

PBS is situated in the Ohio Lake Plain physiographic region. The soil is light-textured and often sandy with moderate to slightly acid pH. Two soil associations (a group of soils geographically associated in a characteristic repeating pattern and defined as a single map unit) are present according to ODNR mapping. The Arkport-Galen association occurs in the northern and western areas of the site, and the Prout association in the southern and eastern areas. Soils are highly variable in thickness and permeability. The following information is taken from *PBS Preliminary Assessment* (SAIC, 1991):

> *The Arkport-Galen association is characterized by deep, nearly level to moderately sloping, well-drained to moderately well-drained soils that have a subsoil of loamy fine sand and fine sand and occur on sand hills and ridges. These soils are formed in very fine sand and deposited by wind and water as beaches, sand bars, and sand dunes. This association is made up of about 40% Arkport soils, 30% Galen soils, and 30% minor soils.*
>
> *The Arkport soils are gently to moderately sloping and well drained. The Galen soils are nearly level and moderately well drained. The minor soils occur in level to depressional areas and in the flat areas between the sand hills and ridges. The minor soil associations are either very poorly or somewhat poorly drained.*
>
> *The Prout association has moderately deep to deep, nearly level to gently sloping, somewhat poorly drained soils that have a subsoil of heavy silt loam to silty clay loam. This association occurs on uplands such as the sides of stream valleys, shale outcrop ridges, along drainage ways, and in some steeper areas.*
>
> *The Prout soils are nearly level to gently sloping, dark colored, and somewhat poorly drained. These soils are underlain by shale bedrock at a depth ranging from 51 to 102 centimeters (20 to 40 inches) for the Prout soils, and 102 to 152 centimeters (40 to 60 inches) for deep variant Prout soils. The minor soils in this association include a broad spectrum from nearly level to depressional and very poorly drained to nearly level to gently sloping and well drained.*
>
> *Bedrock in the area consists of carbonates and clastics (sandstones and shales). Bedrock consists of four Devonian formations: Columbus Limestone, Delaware Limestone, Plum Brook Shale/Prout Limestone, and Ohio Shale. Depth to bedrock is highly variable and can range from 0.7 to 7.6 meters (2 to 25 feet). In scattered locations, the bedrock formations a*re exposed. *A generalized stratigraphic section underlying Plum Brook Station is shown in Figure B4-1.*

Age	Formation/Group	Depth to Top (ft)	Thickness (ft) a	Hydrologic Unit b	Rock Description
DEVONIAN	Ohio Shale	c	300	Zone 3	Shale : *black, thin-bedded with bituminous and carbonaceous material.*
	Prout Limestone/ Plum Brook Shale	Surface	210		Shale : *light grey, calcareous.*
	Delaware Limestone	40	50	Zone 1 and Zone 2	Limestone : *buff, earthy, foss. interbedded with brown crystalline dolomite.*
	Columbus Limestone	90	110		Limestone : *brown to grey, fine crystalline, foss. with tan to buff-grey, partly sandy dolomite at base.*
	Lucas Dolomite	200	70		Dolomite : *brown, crystalline, porous, chert.*
	Amherstburg Dolomite	270	20		Dolomite : *tan to grey, microcrystalline, sl. argillaceous.*
SILURIAN	Bass Island Dolomite	290	30		
	Salina	320	590'		Dolomite : *anhydrite and shale sequence. Interbedded and intercalated. Dolomite is tan to brown and mostly tight. Scattered shale laminae. Few scattered oil stains. Some dolomite is shaly. few massive beds of dolomite and anhydrite.*

Figure B4-1 Generalized Stratigraphic Section Underlying Plum Brook Station

B4.c Seismology

The State of Ohio, including Lewis Field and PBS, is located in Seismic Zone 1 (Ohio Building Code 1990). The probability of an earthquake causing structural damage is minimal. The Ohio Shale is fissile, however, and offers differential resistance to applied stresses depending upon the inclination to the direction of stratification.

B4.d Surface Water Hydrology

Information on drainage and bedrock at Plum Brook Station is located in Chapter B3, Water Resources.

B4.e Coastal Zone Management Issues

Ohio has an approved Coastal Zone Management Plan. Although PBS itself is not located in the Ohio Coastal Zone, the two raw water pumping stations it owns are on the shore of Lake Erie within the designated Coastal Zone. Both of these facilities are consistent with Ohio's Plan.

B4.f Prime and Unique Farmlands

Plum Brook Station is sited in an area known for its agricultural productivity and is bordered by farmland, some of which is leased to local farmers by NASA. Although much of the native soil was disturbed during the construction of Plum Brook Ordnance Works and later by NASA, there are still vast tracts of native soils which have not been disturbed by modern fertilization techniques and herbicide usage. Operations at the Station require large buffer zones and therefore future urbanization of the property is not expected as of this writing.

B4.g Land Acquisition and Land Use

The area surrounding the PBS is largely rural and agricultural. Some food processing facilities are located in the area including dairy and meat processing operations. Tourism and recreation are important economic influences in the Sandusky area during the summer months.

The land originally leased by NACA in 1956 included 202 hectares (500 acres). NASA accepted the land in 1963 after the Ravenna Arsenal certified the land was decontaminated and suitable for unrestricted future use (Morrison Knudsen, 1994). NASA acquired another parcel of approximately 2,428 hectares (6,000 acres) in 1963. In addition to the land NASA owns directly, it has a use permit for 244 hectares (604 acres) from the Ohio Air National Guard. Local farmers lease approximately 393 hectares (972 acres) outside the security fence.

Most of the land at the PBS consists of forestland and old fields. An estimated 75% of NASA's property at PBS is considered unused. The remaining land is used for offices, test facilities, roads, and infrastructure. Other organizations maintaining offices or utilizing space at PBS include the Department of the Interior, Department of Agriculture, the Federal Bureau of Investigation, the U.S. Coast Guard, U.S. Army Reserve, and Ohio Air and Army National Guards.

NASA identified 871 hectares (2,152 acres) of land as excess in 1978. Of this land, 19 hectares (46 acres) were given to the Perkins Township Board of Education for use as a bus transportation center. Approximately 243 hectares (600 acres) in the western area designated as "Parcel 59" have been excessed through the General Services Administration. However, because of special conditions, disposal has not taken place and decisions regarding potential contamination are pending.

A 2001 Species Survey recommended eight specific areas for management as part of the Protected Species Management Strategy at Plum Brook Station. In addition, specific management practices were identified to assist in the growth and restoration of the various plant species located at the station. To date, field burning (under the purview of Ohio EPA and ODNR) and field clearing have been utilized to maintain native species and control undesirable or overgrown species. Specific management objectives are being developed with Federal and State partners and some local experts in an effort to properly restore these management areas. In addition, NASA GRC has entered into an agreement with the Great Lakes Northern Forest Cooperative Ecological Studies Unit (CESU) to partner with universities and state agencies in research projects.

B4.h Current Policies and Procedures for Landscaping Management

A 1994 White House Memorandum on *Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds*, encourages the use of techniques that complement and enhance the local environment and minimize any adverse effects of landscaping. The Memorandum directs Federal agencies to use regionally native plants for landscaping, minimize adverse effects on natural habitats, conserve water in landscaping, and prevent pollution through such techniques as reducing the need for fertilizer and pesticides, minimizing runoff, using integrated pest management, and recycling.

GRC adheres to this Memorandum as well as the recommendations of the *Protected Species Management Strategy for NASA Glenn Research Center and NASA Plum Brook Station* (SAIC 2002). The plan recommends that the planting and propagation of alien species be minimized. The EMO supplies the GRC community with lists of approved species as needed.

GRC is developing a Life Cycle Analysis tool to be used in the design phase of projects, which includes considering cradle-to-grave environmental impacts on land, air, and water, and biological / biodiversity issues.

All planned construction projects at GRC are reviewed for environmental impacts which include adverse effects on the natural habitat and pollution prevention (P2) initiatives. A construction erosion control procedure is currently being developed.

Sustainable Design (SD) is a large construction/architecture concept, also incorporating Life Cycle Analysis. SD is a tool which will be developed by NASA's Kennedy Space Center, the P2 Lead Center.

It is a goal of GRC to exercise integrated pest management practices whenever pest control is necessary. GRC stores, applies, transports, and disposes of pest control materials according to all applicable Federal, State, and local statutes. It is a goal of GRC to minimize the storage, use, and disposal of pesticides onsite. Pesticide use at GRC is exercised with a goal of minimizing both human exposure and adverse environmental impacts.

Affirmative Procurement/Environmentally Preferable Product (AP/EPP) lists are being compiled, using Life Cycle concepts to rate commercial products. AP/EPP incorporates efficient water use as a rating criterion when evaluating products.

Landscaping and GRC internal structure jobs (such as plumbing practices) will be reviewed in the future as a part of AP/EPP, Life Cycle, Sustainable Design, and/or P2.

B5 BIOTIC RESOURCES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to biotic resources. Relevant chapters include:

- Chapter 19 Endangered And Threatened Species

B5.a Environmental Setting

The PBS site is part of a regional ecosystem encompassing Sandusky, parts of Lake Erie, and several Lake Erie Islands. Several natural areas are found in the general vicinity. The Milan State Wildlife Area is located approximately 5 kilometers (3 miles) to the south. The Erie Sand Barrens State Nature Preserve is approximately 305 meters (1000 feet) to the south. The Sheldon Marsh State Nature Preserve is approximately 6 kilometers (4 miles) to the northwest, and the Resthaven Wildlife Area 10 kilometers (6 miles) also to the northwest. Another local natural area is Old Woman Creek, a National Estuarine Research Reserve and State Nature Preserve, which is east of the city of Huron.

B5.b Flora

Much of the information in this chapter was taken from *Protected Species Management Strategy for NASA Glenn Research Center* (SAIC, 2002) and *Biological Inventory of Plum Brook Station* (ODNR, 1995). The *Protected Species Management Strategy for NASA Glenn Research Center*, complete with graphics, is posted on the web at http://osat-ext.grc.nasa.gov/emo/pub/psm-index.htm

The Division of Natural Areas and Preserves conducted a botanical survey of PBS in 1994. During that survey, 327 species of vascular plants were cataloged, of which twelve were listed by the Division as Ohio rare species. The Division of Natural Areas and Preserves was requested to undertake a follow up botanical survey in 2001. The goal of the 2001 survey was to revisit as many of the rare species as possible from the 1994 survey and to enhance the vascular plant catalogue. In 2001, 312 of the species found in 1994 were identified and 219 new additions to the catalogue were made.

The Plant Community Survey of 2001 focused on the development of baseline vegetation maps with community descriptions for PBS. Plant communities and aquatic habitats were identified, mapped, and described by evaluating existing information (aerial photographs, previous reports, and maps) and field surveys. Volume II of the Protected Species Management Strategy summarizes the study and mapping of existing plant communities and aquatic habitats at PBS. In addition, it accompanies electronic GIS data layers that portray this information in a spatial database. The Environmental Management Office manages the GIS database.

The historical context of plant communities at PBS is well documented in *Volume II: Plant Community Survey of Protected Species Management Strategy*, Chapter 3. The PBS occupies an area that is known to have been an extensive prairie complex prior to the European settlement of the area. Many species that are associated with Ohio prairies were located during both surveys.

Plant communities were classified according to the Federal Geographic Data Committee (FGDC) Vegetation Classification Standard (FGDC, 1997). This system is explained in Section A5.

Fifteen formations and fourteen alliances were identified at PBS during the 2001 survey. They are identified at http://osat-ext.grc.nasa.gov/emo/pub/PSMS/Volume%20II/psms-vol2.pdf (p. 77), *Plant Communities at PBS.*

Forest Formations

- Formation: I.A.8.N.c. Conical-crowned temperate or subpolar needle-leaved evergreen forest
- Formation: I.B.2.C.b. Orchards and groves (fruit and nut trees)
- Formation: I.B.2.N.a. Lowland or submontane cold-deciduous forest
  Fagus grandifolia - Acer saccharum - (*Liriodendron tulipifera*) Forest Alliance (FU1)
  Quercus alba - (*Quercus rubra*, *Carya* spp.) Forest Alliance (FU2)
  Quercus rubra – Acer saccharum – (*Quercus alba*) Forest Alliance (FU3)
  Quercus veluntina – Quercus alba Forest Alliance (FU4)
- Formation: I.B.2.N.d. Temporarily flooded cold-deciduous forest
  Fraxinus pennsylvanica - Ulmus americana - Celtis (*occidentalis*, *laevigata*) Temporarily Flooded Forest Alliance (FL1)
  Salix nigra Temporarily Flooded Forest Alliance (FL2)
- Formation: I.B.2.N.e. Seasonally flooded cold-deciduous forest
  Acer rubrum - Fraxinus pennsylvanica Seasonally Flooded Forest Alliance (FL3)
  Quercus palustris - (*Quercus bicolor*) Seasonally Flooded Forest Alliance (FL4)

Shrubland Formations

- Formation: III.B.2.N.a. Temperate cold-deciduous shrubland
- Formation: III.B.2.N.c. Intermittently flooded cold-deciduous shrubland
- Formation: III.B.2.N.f. Semipermanently flooded cold-deciduous shrubland
  Cephalanthus occidentalis Semipermanently Flooded Shrubland Alliance (SL3)
- Formation: III.B.2.N.g. Saturated cold-deciduous shrubland
  Cornus spp. - *Salix* spp. Saturated Shrubland Alliance (SL4)

Herbaceous Vegetation Formations

- Formation: A.5.C.b. Landscaped urban/suburban/rural (residential yards, nurseries)
- Formation: V.A.5.N.c. Medium-tall sod temperate or subpolar grassland
- Formation: V.A.5.N.k. Seasonally flooded temperate or subpolar grassland
  Phalaris arundinacea Seasonally Flooded Herbaceous Alliance (HL2)
  Typha spp. - (*Scirpus* spp. - *Juncus* spp.) Seasonally Flooded Herbaceous Alliance (HL3)
  Phragmites australis Seasonally Flooded Herbaceous Alliance (HL4)
- Formation: V.B.2.N.a. Tall temperate or subpolar perennial forb vegetation
- Formation: V.B.2.N.c. Intermittently flooded temperate perennial forb vegetation
- Formation: V.C.2.N.a. Permanently flooded temperate or subpolar hydromorphic rooted vegetation
  Potamogeton spp. - *Ceratophyllum* spp. - *Elodea* spp. Permanently Flooded Herbaceous Alliance (HL5)

B5.c Fauna

Animals censused at PBS during the 2001 ODNR surveys included birds, amphibians, reptiles, fish, lepidoptera, and bats.

A total of 125 bird species were identified during the 2001 summer birding season at the Plum Brook Station. This total includes 11 species that were considered to be late migrants through the area and 7 species which were classified as visitors only. A general analysis of the results shows very little change in the species diversity on the station since the 1994 survey.

In 2001 amphibians and/or reptiles were recorded from 116 localities in Plum Brook Station. There were 15 localities from 1994 where animals were no longer found, but animals were found at 29 new locations. Twenty-one species have been found including two salamanders, six frogs, one lizard, five turtles, and seven snakes. Two new native species, the milk snake and blue-tail skink were found as well as an introduced species, the red-eared slider. The gray tree frog has been deleted from the list. In addition the area lies within the range of nineteen other species and it is possible that one or more of these may yet be discovered here.

During the fish survey in 1993, 3,028 individuals, representing 13 species and one hybrid were collected, compared to 2,156 individuals, representing 15 species and one hybrid collected in 2001. The small, intermittent nature of the streams in the study area coupled with extensive channel modifications and habitat degradations have resulted in a lower species diversity than would be found in more pristine headwater streams of similar size. With the exception of the brook stickleback, all the species captured in this study were common species statewide, exhibiting high degrees of tolerance to habitat and water quality degradations. A small population of sticklebacks was discovered in a small, shallow pool below a culvert in one of the tributary ditches feeding into Pipe Creek in 1993. This population was still there in 2001.

In a 1994 summer survey of PBS, 41 species of butterflies were recorded. During the summer of 2001, 53 species of butterflies were recorded. Three species observed in 1994 were not seen in 2001. However, fourteen species not recorded in 1994 were found in 2001. The number of species recorded from Erie County has increased from 59 to 70.

After an extensive survey of PBS during the summer of 2001, a total of 450 species of moths were recorded. A previous survey in 1994 recorded 385 species of moths. Of the moths collected in 2001, six species are listed as uncommon, three species are rare, and three species are of special interest. One species on the Ohio Department of Natural Resources Ohio's Endangered Wildlife List was recorded.

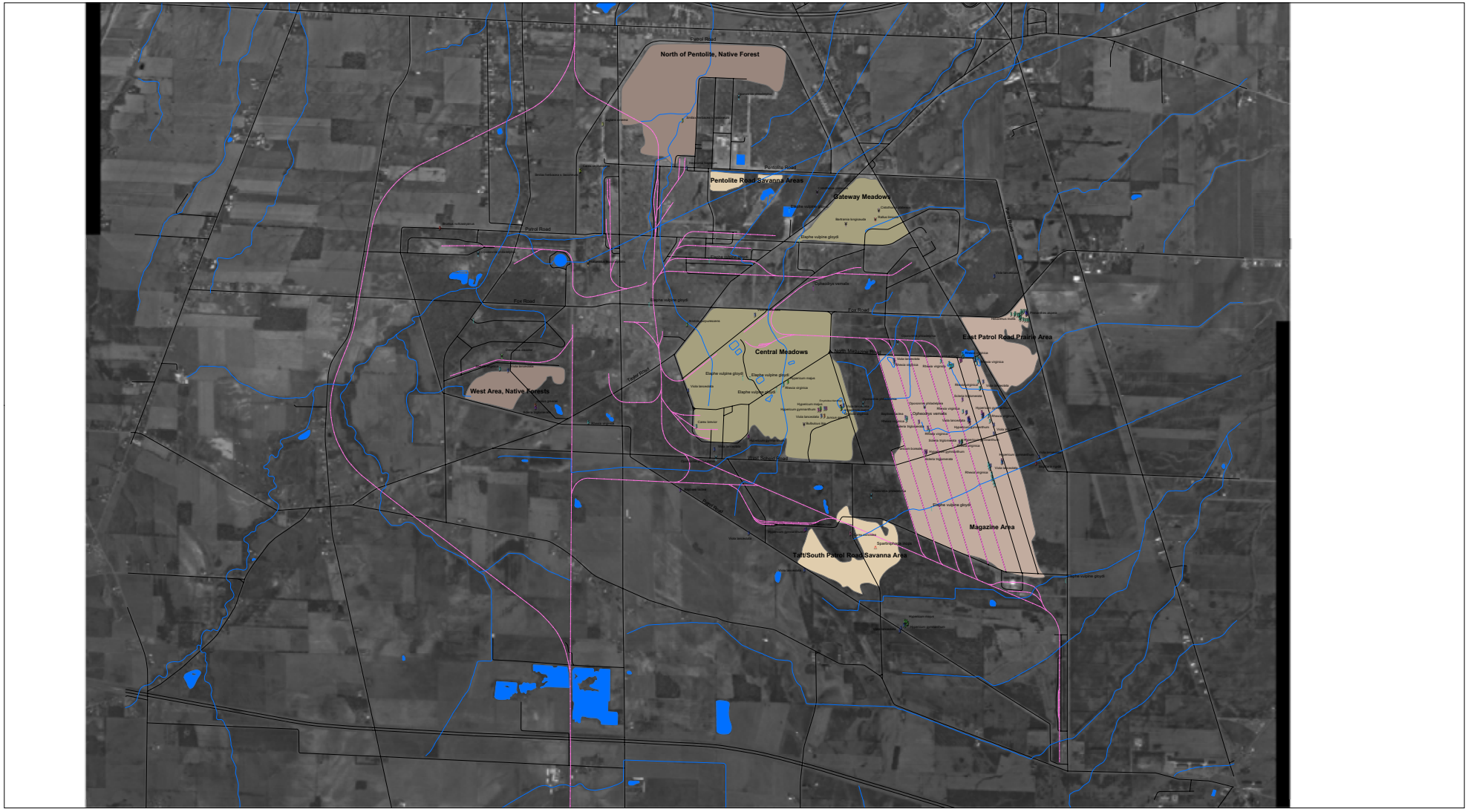
Distribution, diversity and relative abundance of the *Chiropterans* (bats) at PBS were studied from April through September 2001. Methodology included visual and acoustical surveying of the grounds and buildings, the mist netting of wooded, riparian and open sites and radio tracking selected bats within the Station. Eight species of bats totaling 238 were captured at 17 of the 21 mist net sites at Plum Brook Station. There was no evidence of the Indiana bat. Several maternity colonies were located utilized by three different species.

B5.d Unique and Important Habitats

PBS contains vast natural resources in the form of a complex mosaic of plant communities in various successional stages and hydrologic regimes. Much of PBS is undeveloped natural areas or recovering natural areas previously used for agriculture. The size and diversity of natural habitats at PBS support a large number of plant and animal species (see ODNR, 2002 and SAIC, 2002). Many of these areas contain rare plants species and rare plant communities, including rare prairie species and remnant oak savannas.

At PBS, eight core sites containing areas of special vegetation significance were identified as priority areas for management. The eight areas are identified at http://osat-ext.grc.nasa.gov/emo/pub/PSMS/Volume%20III/PBS_Management_areas.pdf, *Species Management Areas at PBS*. These include specific sites with identified populations of rare or state-listed plant species. They can be small and local, or somewhat extensive in area. But in all cases their distinguishing characteristic is that they support a growth of rare plants or can be restored to a condition that supports rare plants. The loss of the most important sites likely would mean the irretrievable loss of the local rare plants, many of which are exceptionally rare or state-listed and found nowhere else in the region or state.

Plate 1. Management Areas at Plum Brook Station



Rare Animal Species

- Spartiniphaga inops
- Emydoidea blandingii
- Elaphe vulpine gloydi
- Opheodrys vernalis
- Cistothorus platensis
- Dendroica discolor
- Haliaeatus leucocephalis
- Oporonrnis philadelphia
- Rallus limicola

Rare Plant Species

- Aristida purpurescens
- Baptisea lactea
- Bromus nottowayanus
- Carex brevior
- Carex cephaloidea
- Carex conoidea
- Gratiola virginica
- Hedeoma hispidum
- Helianthus mollis
- Hypericum gymnanthum
- Hypericum majus
- Juglans cinerea
- Juncus greenei
- Panicum boreale
- Prenanthes aspera
- Rhexia virginica
- Sagittaria rigida
- Scleria triglomerata
- Smilax herbacea v. lasioneura
- Viola lanceolata

Management Areas

- Rare Plant Sites
- Intact Rare Plant Communities
- Degraded Rare Plant Communities
- Rare Plant Community Restoration Area

Other

- Road
- Railroad
- Water Feature Line
- Water Feature Polygon

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B6 ENDANGERED SPECIES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to biotic resources. Relevant chapters include:

- Chapter 19 Endangered and Threatened Species

B6.a Listed Species

The *Biological Inventory of Plum Brook Station* (ODNR 1995) report lists twelve species of rare vascular plants. Two of these, *Carex alata* and *Arenaria lateriflora*, could not be revisited in 2001. The site where the *Arenaria* was located was thoroughly searched, but the species was not found. *Carex alata* is a difficult species to spot and it was rare in 1994. The species may have been overlooked in 2001. The record of *Carex cephaloidea* from 1994 turned out, after examination by an expert at the University of Michigan, to have been based on a misidentification. However, a specimen collected in 2001 was verified to be *Carex cephaloidea*. In 2001, ten new state rare species, in addition to *Carex cephaloidea* were discovered. Many new populations of already known rare plants were also discovered in 2001 (Table B6-1). During the 2001 survey, state listed animal species were located. They are identified in Table B6-2. The results of this survey demonstrate that PBS is one of the most important refuges for rare plant species and prairie remnants in northern Ohio. The federally-threatened bald eagle (*Haliaeatus leucocephalis*) was not observed during the 2001 study, but a pair have since established a nest at PBS.

A brief description of plant species, their ranges, habitats, life history, ecology, and unique characteristics can be found at http://www.dnr.state.oh.us/dnap/heritage/Rare_Species2002.htm. Information regarding animals can be found at http://www.enature.com/.

The *Protected Species Management Strategy For NASA Glenn Research Center At Lewis Field And Plum Brook Station Volume II: Plant Community Survey* divided significant plant communities into four categories:

- Specific Rare Plant Sites
- Intact Rare Plant Communities
- Degraded Rare Plant Communities
- Rare Plant Community Restoration AreasEight distinct management areas were delineated during the study. Areas were categorized as meadows, savannahs, forests, prairie, and other. Six areas contain State Endangered or Threatened Species. The eight management areas, their categories, and acreage are listed in Table B6-3. A map of these areas can be found at http://osat-ext.grc.nasa.gov/emo/pub/PSMS/Volume%20III/PBS_Management_areas.pdf.

Table B6-1 State-listed Plant Species at the Plum Brook Station

Endangered	**Years located**
Carex cephaloidea (thin-leaf sedge)	2001
Hypericum gymnanthum (least St. John's wort)	1994/2001
Juncus greenei (Greene's rush)	2001
Prenanthes aspera (rough rattlesnake root)	2001
Threatened	
Carex conoidea (field sedge)	1994/2001
Hedeoma hispidum (rough pennyroyal)	2001
Helianthus mollis (ashy sunflower)	1994/2001
Panicum boreale (northern panic grass)	2001
Sagittaria rigida (deer's tongue arrowhead)	2001
Smilax herbacea v. *lasioneura* (pale carrion flower)	2001
Potentially Threatened	
Arenaria lateriflora (grove sandwort)	1994
Aristida purpurescens (purple triple-awned grass)	2001
Baptisea lactea (prairie false indigo)	1994/2001
Carex alata (broad- winged sedge)	1994
Gratiola virginica (short's hedge- hyssop)	1994/2001
Hypericum majus (tall St. John's wort)	1994/2001
Juglans cinerea (butternut)	2001
Rhexia virginica (Virginia meadow- beauty)	1994/2001
Scleria triglomerata (tall nut-rush)	1994/2001
Viola lanceolata (lance- leaved violet)	1994/2001
Added	
Bromus nottowayanus (satin brome)	2001
Carex brevior (tufted fescue sedge)	2001

B6.b Endangered Species Management

The *Protected Species Management Strategy For NASA Glenn Research Center At Lewis Field And Plum Brook Station Volume III: Management Plan* made recommendations for general management of significant plant communities at PBS. The recommendations included:

- Restorative landscape fires during the dormant dry period in March and April
- Asian honeysuckles and other foreign invaders should be monitored and removed as needed
- Rare species should be carefully re-seeded and reintroduced
- More common prairie plants and forbs (many species) should be properly reintroduced
- Mowing along roadsides should be curtailed during the growing season
- The deer population should continue to be controlled

Table B6-2 State-listed Animal Species at the Plum Brook Station

Endangered	**Years located**
Bulbulcus ibis (cattle egret)	1994/2001
Haliaeetus leucocephalus (bald eagle)	2002
Spartiniphaga inops (moth, no common name)	2001
Threatened	
Bartramia longicauda (upland sandpiper)	1994
Nycticorax nyctcrax (black-crowned night heron)	1994/2001
Special Interest/Concern	
**Casmerodius albus* (great egret)	1994/2001
**Dendroica discolor* (black-throated green warbler)	1994/2001
Emydoidea blandingii (Blanding's turtle)	1994
Elaphe vulpine gloydi (Eastern fox snake)	1994/2001
**Oporonrnis philadelphia* (mourning warbler)	2001
**Opheodrys vernalis* (smooth green snake)	1994/2001
Rallus limicola (Virginia rail)	2001

* = Division of Natural Areas and Preserves listing

Table B6-3 The Eight Species Management Areas at the Plum Brook Station

AREA NAME	CATEGORY	ACREAGE
East Patrol Road	Rare Prairie Plant Site	78
Magazine Area	Rare Prairie Plant Site	504
Pentolite Area	Native Forests	227
West Area	Native Forest	55
South Patrol Road and Taft Road	Savanna Areas	90
Pentolite Road	Savanna Area	17
Central	Meadows Area	458
Gateway	Meadow Area	99

The *Management Plan* describes specific recommendations regarding individual species and distinct management areas.

The EMO, in conjunction with the Plum Brook Management Office (PBMO) will establish a management board for the management of PBS's biological resources. The board will review and approve all proposals to ensure that activities to manage, preserve, and restore habitat are appropriate and consistent with PBS's continuing and future research and test operations. The board will be composed of representatives from appropriate offices at GRC and representatives of the ODNR. The board will also develop restoration partnerships, seek outside funds and volunteer services whenever possible, and attempt to strengthen PBS relations with the community.

Partnerships will be established with conservation organizations and museums. GRC will adopt ODNR recommendations, as appropriate, until the management board establishes priorities.

B7 WETLANDS AND FLOODPLAINS

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to floodplain and wetlands. Relevant chapters include:

- Chapter 18 Floodplain and Wetlands Management

B7.a Floodplains

According to Flood Insurance Rate Maps (FIRM), published by the Federal Emergency Management Agency (FEMA), floodplains at PBS occur in narrow strips of lowland parallel to streams. Copies of the FIRM for PBS are maintained by the Environmental Compliance Team. The Erie County Board of Commissioners published maps of the 100 and 500 year floodplains at PBS in the early 1970's. These maps are maintained by the Environmental Compliance Team. In 1984 the Army Corps of Engineers prepared flood profile maps for the four largest streams at PBS. These maps are maintained by the Environmental Compliance Team.

No PBS facilities remain in the 100-year floodplain. There are no activities currently located in floodplains at PBS. It is GRC policy to restore, preserve, and protect the natural and beneficial values provided by floodplains. In carrying out this policy, GRC avoids adverse impacts associated with the occupancy and modification of floodplains.

There is concern regarding possible sources of contamination within the floodplain. The West Area Red Water Pond A-2 is entirely within the 100-year and 500-year floodplain. West Area Red Water Pond A-1 is in the 500-year floodplain and the Disposal Area 2A is partially within the 100-year and 500-year floodplains (Morrison Knudsen, 1994). Both of the West Area Red Water Ponds have been taken into consideration as part of the PBOW USACE remediation program for Formerly Utilized Defense Sites (FUDS). A recent baseline Ecological Risk Assessment (IT Corporation, 2001) conducted for the PBOW remediation program determined that further remediation at the West Area Red Water Ponds was not recommended. That determination has not been approved by Ohio EPA.

B7.b Wetlands

For regulatory purposes, wetlands must have all of the following three attributes:

1. at least periodically, the land supports plants adapted to grow in water;
2. the substrate is predominantly undrained soil having or characterized by excessive moisture;
3. the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

Wetlands at PBS have not been officially delineated. Accurate interpretations of jurisdictional status require site-specific field delineation. Until an official delineation occurs, PBS must rely on studies which indicate the potential or probable locations of wetlands at PBS. Copies of the wetland indicator maps for GRC are maintained by the Environmental Compliance Team. Reference can be made to the *Final Protected Species Management Strategy For NASA Glenn Research Center At Lewis Field And Plum Brook Station, Volume II: Plant Community Survey* (SAIC, 2002) for the probable locations of wetlands at PBS.

Eight vegetation formations and thirteen alliances at PBS were identified during the 2002 survey as probable wetlands. They were:

1. Formation: I.B.2.N.d. Temporarily flooded cold-deciduous forest

Fraxinus pennsylvanica - Ulmus americana - Celtis (*occidentalis, laevigata*) Temporarily Flooded Forest Alliance (FL1)

This forest alliance is associated with floodplains near streams and rivers and other temporarily flooded areas. It is quite rare at PBS, but not uncommon regionally. A young example of this community is located north of Pentolite Road, east of the reactor facility. It appears to be an area where standing water may be present during the spring. The ODNR (1993) plant community study used the Anderson (1982) classification "Maple-Ash Swamp" and AMixed Floodplain Forest" to describe this alliance.

Salix nigra Temporarily Flooded Forest Alliance (FL2)

This floodplain forest alliance is a very minor component of PBS. It is generally found immediately adjacent to streams. A small example of this alliance is located just east of the intersection of Taylor and Maintenance Roads along Plum Brook.

2. Formation: I.B.2.N.e. Seasonally flooded cold-deciduous forest

Acer rubrum - Fraxinus pennsylvanica Seasonally Flooded Forest Alliance (FL3)

This forest alliance contains a mixture of upland, mesic species in combination with hydrophytic species. It is located in areas subject to seasonal flooding. A large example of this alliance is located in the northern portion of PBS, north of Pentolite Road and west of the reactor facility. The ODNR (1993) plant community study used the Anderson (1982) classification "Mixed Swamp Forest" to describe the presence of this alliance.

Quercus palustris - (*Quercus bicolor*) Seasonally Flooded Forest Alliance (FL4)

This forest alliance is characterized by species tolerant of seasonally saturated or inundated conditions. Standing water (e.g., vernal pools) is often present in the spring and early summer. By late summer and fall, these areas generally are dry. There appear to be two different types of this forest at PBS depending on surface topography and underlying geology. The first is more typical of the alliance and shows evidence of surface ponding during the spring with herbaceous hydrophytes fairly common. An example of this type is located west of Ransom Road near the southern boundary of PBS. The second type does not display evidence of surface ponding nor are herbaceous hydrophytes particularly common. Shallow groundwater appears to sustain the hydrophytic tree species. An example of this type is located along the East Patrol Road north of Fox Road. The Anderson (1982) classification "Oak-Maple Swamp" also is used to describe this alliance.

3. Formation: III.B.2.N.c. Intermittently flooded cold-deciduous shrubland

Intermittently flooded mid-successional cold-deciduous shrubland (SL1)

Species and age composition of the Intermittently flooded mid-successional cold-deciduous shrubland community is very similar to the Dry mid-successional cold-deciduous shrubland community. However, this community is characterized by the presence of additional species found in wet environments. These hydrophytic species are generally found in patches in scattered, depressional areas and do not dominate the community. Patchy saturated soils and evidence of previous ponding also characterize this community. The magazine area contains a number of examples of this community.

Intermittently flooded late-successional cold-deciduous shrubland (SL2)

This community is more advanced stage of the slightly wet "Old Field Community" (see Intermittently flooded mid-successional cold-deciduous shrubland). In some cases, it is characterized by very dense patches of mature gray dogwood (*Cornus racemosa*) (3 to 5 m in height). An example of this community is located along the eastern boundary of PBS between Columbus Avenue and East Patrol Road.

4. Formation: III.B.2.N.f. Semipermanently flooded cold-deciduous shrubland

Cephalanthus occidentalis Semipermanently Flooded Shrubland Alliance (SL3)

This shrub swamp alliance is quite rare at PBS. It is dominated by woody species including buttonbush (*Cephalanthus occidentalis*). Floating aquatics such as duckweed (*Lemna* spp.) are common in deepwater areas. This alliance occupies shallow water areas (e.g., depressions, ponds, floodplains) throughout the eastern United States. At PBS, an example of this community is located within a larger forest community, west of Taft Road and north of South Patrol Road. The shallow water areas of several ponds contain small examples of this community. The Anderson (1982) classification "Buttonbush Shrub Swamp" is also used to describe this community.

5. Formation: III.B.2.N.g. Saturated cold-deciduous shrubland

Cornus spp. - *Salix* spp. Saturated Shrubland Alliance (SL4)

This shrub swamp alliance is dominated by woody species including dogwood species (*Cornus* spp.). The dogwood-willow swamp alliance occurs in two forms at PBS. The first occurs in moist openings and depressions where dense patches willow (*Salix* spp.) patch appear. A number of these patches occur in the open fields around the main office building on Columbus Avenue. The second type is a true dogwood-willow swamp. The best example is located within a wooded area east of Short Cut Road and north of Fox Road. This depressional area holds ponded water much of the year. It is one of the few areas at PBS able to support a large population of skunk cabbage (*Symplocarpus foetidus*). The Anderson (1982) classification "Mixed Shrub Swamp" is also used to describe this community.

6. Formation: V.A.5.N.k. Seasonally flooded temperate or subpolar grassland

Phalaris arundinacea Seasonally Flooded Herbaceous Alliance (HL2)

According to TNC (1997) this alliance occurs as a natural community in the northeastern United States, but its presence as a natural community elsewhere is uncertain. This alliance is found most often in depressional areas and swales in previously cleared fields. An example of this

community is located in the open field just south of the woodlot located directly across Pentolite Road from the reactor facility.

Typha spp. - (*Scirpus* spp. - *Juncus* spp.) Seasonally Flooded Herbaceous Alliance (HL3)

This shallow marsh alliance is characterized by cattails (*Typha* spp.), bulrushes (*Scirpus* spp.), rushes (*Juncus* spp.) and other hydrophytes. Saturated or inundated conditions prevail during much of the growing season, but water depths generally do not exceed 15 cm (~ 6 inches). Several examples of this community are located near ponds and ditches along North Magazine Road. The Anderson (1982) classification "Mixed Emergent Marsh" also is used to describe this community.

Phragmites australis Seasonally Flooded Herbaceous Alliance (HL4)

The community is characterized by the highly invasive giant reed (*Phragmites australis*) often occurring as a monoculture. The giant reed form dense tall stands, which exclude native plants. This community offers little habitat to wildlife and is highly undesirable due to its invasive nature. The roadside ditch along Pentolite Road across from the reactor facility contains this community. Several large patches occur in the field south of this ditch. The roadside ditch east of the Space Power Facility also contains this community.

7. Formation: V.B.2.N.c. Intermittently flooded temperate perennial forb vegetation

Intermittently flooded early successional herbaceous field (HL1)

Species composition of this community is very similar to the Dry early-successional herbaceous field community. However, this community is characterized by the additional presence of species found in wet environments. These hydrophytic species generally are found in patches in depressional areas and do not dominate the community. One large example of this community is located the along East Patrol Road south of Fox Road. This field contains the largest population of the state-threatened ashy sunflower (*Helianthus mollis*) in Ohio. Many other pockets of rare plants occur in similar herbaceous fields throughout PBS.

8. Formation: V.C.2.N.a. Permanently flooded temperate or subpolar hydromorphic rooted vegetation

Potamogeton spp. - *Ceratophyllum* spp. - *Elodea* spp. Permanently Flooded Herbaceous Alliance (HL5)

This alliance occurs in shallow open water areas generally less than 2 m deep. TNC (1997) defines this alliance as having up to 25% cover by emergents or floating-leaved aquatics and at least 25% submerged aquatics. The ponds between North Magazine Road and Fox Road contain good examples of this community. The Anderson (1982) classification "Submergent Marsh" also is used to describe this community.

Additional guidance is found in the publication *Soil Survey of Erie County, Ohio February 2002 Interim Report,* which is also maintained by the Environmental Compliance Team.

The Environmental Compliance Team also maintains a copy of the Wetlands Inventory Map of the Sandusky and Kimball, Ohio quadrangles (USFWS, 1977), which encompass PBS. These maps do not indicate wetlands at PBS.

Facility relocation surveys conducted in 1998 and 2002 in support of the Cleveland Hopkins International Airport expansion project also did not identify any wetlands. Past site modifications at PBS have included the construction of drainage ditches to prevent the accumulation of standing water, thereby reducing the potential for wetland formation.

There are no known activities currently located in wetlands. It is GRC policy to restore, preserve, and protect the natural and beneficial values provided by and wetlands. In carrying out this policy, GRC avoids adverse impacts associated with the occupancy and modification of wetlands.

PBS is not engaged in a wetlands banking program.

B8 SOLID WASTE GENERATION, TREATMENT, STORAGE AND DISPOSAL

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to solid waste generation, treatment, storage, and disposal. Relevant chapters include:

- Chapter 5 Management Of Hazardous Materials And Waste For Reuse, Recycling, Or Disposal
- Chapter 6 Pollution Prevention and Greening the Government Plan (P2 and GtG Plan)
- Chapter 9 Asbestos
- Chapter 17 Solid Waste
- Chapter 33 Bloodborne Pathogens (e.g., medical waste)
- Chapter 34 Handling and Disposal of Soil

B8.a Current and Projected Waste Streams

Solid wastes generated by PBS include office waste, paper, used equipment, construction and demolition debris, and wastes from routine maintenance. See Table B8-1.

Table B8-1 Solid/Hazardous Waste Generation at PBS *

MATERIAL DISPOSED	Annual - 2002		Projected - 2003	
	Metric	English	Metric	English
Non-hazardous Waste				
Lab Pack Material	268 kg	592 lb	278 kg	615 lb
PCB (TSCA)	1,741 kg	3,847 lb	1,809 kg	3,997 lb
Petroleum Product	7,154 l	1,890 gal	7,433 l	1,964 gal
Soil, Non-Hazardous	181 kg	400 lb	188 kg	416 lb
Recyclable Material	37 kg	82 lb	38 kg	85 lb
Spill Response	646 kg	1,424 lb	671 kg	1,480 lb
Remedial Activity	112 kg	248 lb	116 kg	258 lb
Recyclable Solid Waste	37 kg	82 lb	38 kg	85 lb
Solid Waste	98 m^3	133 cy	105 m^3	143 cy
Other	138 kg	304 lb	143 kg	316 lb
Hazardous Waste				
Lab Pack Material	2,418 kg	5,330 lb	2,512 kg	5,538 lb
Soil, Hazardous	41 kg	90 lb	43 kg	94 lb
Spent Solvents	162 kg	357 lb	168 kg	371 lb
Recyclable Material	336 kg	741 lb	349 kg	770 lb
Spill Response	646 kg	1,424 lb	671 kg	1,480 lb
Remedial Activity	37 kg	82 lb	38 kg	85 lb
Other	46 kg	101 lb	48 kg	105 lb

*Waste generated and tracked for CY2002. All wastes generated have been characterized per RCRA Solid Waste requirements. Hazardous and non-hazardous soils have been characterized and have been determined to be either RCRA regulated solid wastes or commercial/industrial fill as determined by CERCLA Voluntary Action Program (VAP) standards. Solid waste is defined as paper, cardboard, tin cans, metal glass, rubber, plastic, landscaping brush, wood, garbage and other miscellaneous debris.

There are 19 collection containers for solid waste on site which are emptied on a weekly or bi-weekly basis. Waste generation rates were reported at 5 to 24 cubic meters (6 to 32 cubic yards) per week. Waste is disposed of at the Erie County Sanitary Landfill. There are no solid waste disposal locations on site.

White bond and computer paper are collected for recycling. Scrap metals such as steel, copper, brass, and aluminum are collected in separate containers and are also recycled. Printer and toner cartridges are also collected and recycled through the GRC Logistics Division.

B8.b Hazardous and Toxic Waste Management

The PBMO is responsible for the management of hazardous materials at PBS, coordinating in this task with the EMO. An environmental audit reported that PBS uses approximately 250 different hazardous materials including fuels, gasoline, laboratory chemicals, propellants, gases, paints and coatings, lubricants, herbicides, and heating oil (Foster Wheeler, 1996). Aside from bulk materials such as fuels, most hazardous substances are used in small quantities.

The PBS has been assigned Ohio EPA RCRA identification number OH 3800015379. PBS is a classified as a large-quantity generator due to high-volume wastes from past underground storage tank removals. Hazardous wastes are collected from four possible satellite accumulation points (Buildings 1441, 3211, 3411, and 7131) and brought to Building 9206 for consolidation and storage for less than 90 days. All areas where hazardous wastes are stored have secondary containment. No treatment or disposal takes place on site. No RCRA Part A or Part B permit is required.

Typical hazardous wastes from PBS consist of used solvents (chlorinated and non-chlorinated), oils, laboratory chemicals, fuels, lab packs, and wastes from maintenance operations. There is no segregation or reclamation of used solvents because the quantities involved are relatively small. When not contaminated, used oils may be recycled or used for fuel blending.

PBS maintains an on-site chemical inventory and copies of MSDSs. PBS submits Tier I/Tier II reports, TRI reports, and emergency preparedness plans in compliance with the Emergency Planning and Community Right-To-Know Act. There are 2 UST's and 10 above ground storage tanks at PBS which are used to store gasoline and diesel fuel. All new underground storage tanks have double wall fiberglass-reinforced plastic for tanks and piping. All above ground tanks greater than 600 gallons have secondary containment (Foster Wheeler,, 1996).

From 1989 to 1994, PBS carried out an aggressive UST removal and replacement program. Some 21 UST's were removed from nine locations. Any visibly-contaminated soil was removed from the excavation cavity for proper disposal. Three of the UST sites required RCRA corrective action. Tanks which were at the Space Power Facility, Maintenance Garage, and the Research Reactor Building stored materials considered hazardous wastes. These tanks were removed and closure plans submitted to the Ohio EPA in 1995 for comment (Foster Wheeler, 1996). The Space Power Facility clean up project has been closed without further action. The Garage and Maintenance Area and the Reactor Area required additional cleanup of the surrounding soil and groundwater. At the Garage and Maintenance Area, a vacuum-enhanced groundwater extraction (VEGE) system was pilot tested in 1999 and is the process of installation scheduled for operation by 1 October 2003. At the Reactor Area, a pump and treat system is in the process of installation at the time of this writing. The system runs groundwater from building sumps and one additional well through granular activated carbon (GAC) units for ultimate discharge into the surface waters. The remediation activities will be monitored and results forwarded to Erie County Environmental Services and the Ohio EPA.

Several investigations of possible contamination at PBS have taken place over the years. One such study was a CERCLA Preliminary Assessment of potential locations and sources of hazardous substance

contamination (SAIC, 1991). This study identified 14 operable units for which there was evidence of possible contamination. A CERCLA Site Inspection then evaluated these locations through soil, sediment, surface water, and groundwater sampling (Morrison Knudsen, 1994). The sampling and other data were used to derive a Hazard Ranking System score for the PBS site. The score for the entire study area was 7.99, less than the minimum of 28.50 typically required to be placed on the CERCLA National Priorities List. Scores for the five individual subareas (or Project Management Units) were also less than 28.50. The Site Inspection recommended no further remedial action under CERCLA. PBS received a No Further Remedial Action Planned letter from the USEPA in October 1994.

In addition to CERCLA actions, a RCRA Facility Assessment in the form of a Preliminary Assessment/Visual Site Inspection (PA/VSI) was conducted in 1998. The PA/VSI was initiated by the 1997 Administrative Order on Consent issued by the Attorney General of Ohio to NASA regarding the Finding of No Further Action letter from the USEPA. A total of 20 Solid Waste Management Units (SWMUs) and 6 Areas of Concern (AOCs) were identified during the PA/VSI. The PA/VSI recommended that 15 of the SWMUs and the 6 AOCs be investigated further based on moderate to high release potentials.

As a result of past Army activities at PBS during the PBOW operations, the USACE is also conducting remedial activities under the Defense Environmental Restoration Program for FUDS. Thus far, areas of concern have been identified and prioritized based on historical information and available field data. A Site Investigation is evaluating these areas to determine their environmental significance, after which remediation will be carried out as needed. In 2002 soil remediation began at TNT Area B in accordance with the approved Remedial Investigation Plan. USACE activities at PBS are being conducted in coordination with NASA and the Ohio EPA.

In 1980, several thousand gallons of diesel oil were released from a UST at the SPF and flowed to one of the PBS sewage treatment plants. As much oil as possible was recovered and contaminated media were disposed of at a county landfill. The Coast Guard was involved and was satisfied that the pollution had not spread (Morrison Knudsen, 1994).

In 1978, approximately 6,056 liters (1600 gallons) of raw coal tar naphtha were released from a fuel storage trailer. The spill was contained in an earthen retention basin and recovered for off-site disposal. It is believed that none of the spilled material was released to surface waters.

In 1976, 189 to 284 liters (50 to 75 gallons) of No. 2 fuel oil were released from an above ground storage tank. The spill was contained in a catch basin and recovered to the extent possible. Contaminated plants and soil were removed and the site was monitored to ensure clean-up efforts were effective.

The Plum Brook Management Office

- Coordinates the transfer of the hazardous materials and wastes to Building 9206 for temporary storage (90-day maximum for materials determined to be a hazardous waste) while a means of reuse, recycling or disposal is determined.
- Maintains original files on all hazardous and non-hazardous waste shipments for regulating agency review.
- Maintains all records on required hazardous waste management and DOT training for PBS staff.
- Notifies WMT through the use of NASA GRC Form C-260a to arrange for a waste disposal contractor to pick up and dispose the hazardous waste.

It is GRC policy that special attention is given to the management of hazardous materials no longer required for ongoing institutional operations, research programs, or related activities. These hazardous materials are to be managed in a safe and proper manner following the requirements and standards prescribed in the following authorities and GRC procedures.

Users of hazardous or toxic materials have the following responsibilities:

- The user cannot simply dispose of hazardous materials by indiscriminately throwing the material or waste into the trash container or dumping it down the drain.
- Ensures that each hazardous material or waste to be turned in is properly identified and labeled as to its contents and its potential hazard. The Waste Management Team (WMT) should be contacted at 3-2124 to assist in the identification and labeling of materials and wastes to be turned in.
- Prepares a NASA C-260a, "Waste Disposal Request", and submits it to the WMT for determination of proper disposal. The C-260a can be found in the GRC Electronic Forms Library at: http://forms.grc.nasa.gov/Forms/PublicUser/index.cfm

Logistics and Technical Information Division (LTID) Property Disposal forwards the GRC Property Disposal Turn-in Document, NASA C-260, as required, either to the WMT or the Environmental Compliance Team (ECT) to determine the ultimate disposition of materials or equipment that may contain a hazardous material or waste.

The Environmental Compliance Team (ECT)

- Provides technical input to the Property Disposal Officer via the NASA C-260 for managing hazardous materials and disposing of equipment containing hazardous material.
- Provides technical direction, methodology, and consultation to any user for turn in of hazardous materials, equipment containing hazardous material, and soils containing hazardous materials.
- Provides analytical chemistry support for identifying unknown materials prior to turn in for disposal.
- Assures that hazardous waste disposal contractors under contract to GRC conduct their activities at a licensed/permitted waste disposal facility.
- Maintains responsibility for signing all hazardous waste manifests. ECT shall investigate and inquire, as necessary, regarding shipments prior to signing the manifests. At Plum Brook, the Plum Brook Management Office maintains responsibility for signing all hazardous waste manifests.
- Performs at least one compliance audit per year on the Hazardous Waste Management function. Provides an audit report to the Chief of the Environmental Management Office (EMO). EMO issues orders to address audit deficiencies.
- Educates personnel on hazardous material and hazardous waste handling and waste reduction.

Waste Management Team (WMT) has the following responsibilities.

- Develops and implements a program for managing hazardous materials and disposing of hazardous wastes.
- Provides documentation to the Property Disposal Officer records of shipment for disposal of hazardous wastes and materials.
- Recommends to and educates the user in the proper procedures to be followed when turning in a hazardous material or disposing of hazardous waste. Also, educates all staff at GRC on hazardous material, hazardous waste handling and waste reduction/minimization.
- Coordinates the transfer of the hazardous materials and wastes to Building 212, the Central Chemical Storage Facility, for temporary storage (90-day maximum for materials determined to be a hazardous waste) while a means of reuse, recycling or disposal is determined.

- Determines whether hazardous material can be reused, recycled, or needs to be disposed of as hazardous waste.
- Coordinates with ECT the method of disposal being used.
- Arranges for a waste disposal contractor to pick up and deliver the hazardous waste to a disposal facility, as required.
- Reviews all supporting documentation for compliance with the provisions of Title 49 CFR, Department of Transportation, for the shipment of hazardous materials and Title 40 CFR, EPA, for the disposal of hazardous wastes.
- Prepares, packages, marks, labels, and certifies the packaging and crating of materials and wastes for shipment.
- Prepares Uniform Hazardous Waste Manifests for items such as oils, solvents, chemicals, and hazardous soils not covered by other FD contracts in accordance with EPA and DOT specifications.
- Tracks all manifests to ensure they are accounted for and properly signed.
- Maintains original files on all hazardous and non-hazardous waste shipments for regulating agency review.
- Provides and maintains all records on required hazardous waste management and DOT training for GRC.
- Coordinates and provides required annual training updates.
- Prepares required regulatory and NASA reports.

B8.c Solid Waste Management

The Annual Waste Disposal report on waste disposed in 2002 is listed in Table B8-1.

B8.d Pollution Prevention

PBS has a Spill Prevention, Control, and Countermeasure Plan (2002). The Plan describes procedures for the prevention and control of oil spills, including PCB-containing oil spills, and specifies program responsibilities, training, spill reporting, location of response equipment, and emergency response procedures. PBS is also represented on the GRC P2 Team. PBS began two key initiatives for 2003:

- Beginning a feasibility study for the replacement of trichloroethane; and
- Developing a risk matrix for the PBS EMS.

B9 TOXIC SUBSTANCES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to toxic substances. Relevant chapters include:

- Chapter 3 Water Pollution Control
- Chapter 4 Air Pollution Control
- Chapter 5 Management Of Hazardous Materials And Waste For Reuse, Recycling, Or Disposal
- Chapter 6 Pollution Prevention and Greening the Government Plan
- Chapter 7 Polychlorinated Biphenyls Policy
- Chapter 9 Asbestos
- Chapter 10 Synthetic Inorganic Fiber Program
- Chapter 13 Lead
- Chapter 14 Elemental Mercury
- Chapter 17 Solid Waste
- Chapter 34 Handling and Disposal of Soil

B9.a Exposure Standards and Effluent Limits Under the Clean Water Act

Refer to Section B3, subsection B3.d, for a discussion of exposure standards and effluent limits under the Clean Water Act. Also refer to the same chapter for a discussion of quantities and major sources of toxic water pollutants.

B9.b Exposure Standards and Effluent Limits Under the Clean Air Act

Title III of the CAAA authorized the establishment of regulations on emissions of listed Hazardous Air Pollutants (HAP). These rules are in addition to the older National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations for asbestos, inorganic arsenic, benzene, beryllium, mercury, radionuclides, radon, vinyl chloride, and fugitive emissions. In general the NESHAP requirements will be to install the Maximum Achievable Control Technology (MACT) for specific operations. The MACT baseline is set as the most effective 12% of the controls used in an industrial category. A major source is a facility with the annual potential to emit 9 metric tons (10 tons) of any single HAP or 23 metric tons (25 tons) of a combination of 2 or more HAPs. There are some NESHAP requirements that apply to area sources. An area source is non-major activities located at non-major facility.

Currently, PBS is classified as minor for HAPs. This means that no single operation at PBS is a major source of HAPs and no combination of sources are considered as a major source of HAPs. Should this classification change, PBS's control of HAP emissions could be governed by the developing NESHAP and MACT standards covering any of the operations occurring at the PBS. Some examples include the use of boilers, process heaters, engine testing, reciprocating internal combustion engines, and various surface coating operations. PBS does have an area source that falls under NESHAP-MACT regulations that is applicable for a precision degreasing operation. PBS is investigating updating this operation to eliminate the area source NESHAP requirements.

B9.c Management Programs Implemented for Toxic Substances Control Act (TSCA)

Polychlorinated Biphenyls (*PCBs) and existing techniques for control*

PCB wastes at PBS are stored in a separate area of Building 9206 (the hazardous waste storage building). An annual assessment of PCBs indicated that there were four PCB transformers and 255 high-voltage PCB capacitors in service as of the end of 1995 (LeRC, January 1996). These units contained 6,323 kilograms (13,940 lbs) of PCB oils. A disposal shipment of PCB-contaminated items in April, 1995 consisted of 6,662 kilograms (14,690 lbs) of PCB oil, 45 kilograms (99 lbs) of PCB-contaminated solid debris, and 23,154 kilograms (51,055 lbs) of transformers. The shipment included all PCB wastes in storage at that time.

In 1981, there was a spill of approximately 643 liters (170 gallons) of PCB-contaminated oil onto the concrete floor of Building 9206. Recovery operations captured approximately 70% of the spilled material. The remaining oil leaked under the floor and resulted in soil contamination. Remediation actions included removal of the contaminated soil and free liquids. Four groundwater monitoring wells were installed and revealed no groundwater contamination. Total decontamination was performed in 1989 and groundwater monitoring discontinued a year later after consultation with US EPA.

Asbestos and Synthetic Inorganic Fibers and existing techniques for control

No major asbestos abatement projects were active at PBS during an audit conducted in 1996 (Foster Wheeler, 1996). Some areas at the PBRF are scheduled for abatement and there is an ongoing operation and maintenance program. After a 1986 environmental audit revealed degradation of asbestos insulation, a program was implemented which prioritized abatement actions and undertook removal and disposal actions.

Lead and existing techniques for control

The EMO has established the minimum requirements for the handling, use, removal and disposal of all lead-containing materials in the Environmental Programs Manual (EPM), Chapter 13. The program is applicable to all personnel at GRC.

GRC maintains a data base of the lead-containing materials sampling results and an on-going facilities lead survey being conducted at Plum Brook Station. If Areas of Concern (AOC) with lead-containing materials are encountered, the areas are contained and/or remediated.

All lead containing materials are collected and disposed of in accordance with environmental regulations. The Waste Management Team (WMT) is responsible for the disposal of lead contaminated waste.

Radon and existing techniques for control

Teledyne Isotopes conducted a comprehensive radiological survey of the PBS in 1986 and 1987. That study determined that over half of the site is underlain by Huron shale which often exhibits elevated levels of background radioactivity. In a more recent study, samples of surface water and sediments showed low levels of radioactivity, consistent with what might be expected, given the geology of the site (Morrison Knudsen, 1994).

No systematic radon surveys of all the buildings at PBS have been performed. Four facilities were surveyed in 1989: the Reactor Facility; B2 spray chamber; HTF; and the Plant Protection Building. The results were all below EPA recommended guidelines.

B10 PESTICIDES

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to pesticides and herbicides. Relevant chapters include:

- Chapter 31 Pest Control

B10.a Initiatives to Reduce Pesticide Use

It is a goal of GRC at PBS to exercise integrated pest management practices whenever pest control is necessary. GRC policy is store, apply, transport, and dispose of pest control materials according to all applicable Federal, state, and local statutes. It is a goal of GRC to minimize the storage, use, and disposal of pesticides onsite. Pesticide use at GRC is exercised with a goal of minimizing both human exposure and adverse environmental impacts.

B10.b Management Practices

The Plum Brook Management Office manages the pest control program at PBS and develops an annual Pest Control Plan. The Plan is signed by the PBS Environmental Manager and implemented by a contractor. The use of pesticides at PBS is limited to herbicides only. Building 9103 is used for pesticide storage and mixing. Less than 189 liters (50 gallons) of chemicals are in storage at any given time.

Non-selective herbicides are applied along the fence line for vegetation control. Approximately 50 gallons are used each spring with additional applications if needed. No fertilizers are used on lawn or forest areas, nor are any restricted pesticides used. Pesticides are not normally used in buildings.

In addition to vegetation control for normal PBS operations, the USDA conducts experiments using various herbicides in conjunction with airport vegetation control research. These herbicides are included in the PBS inventory.

Table B10-1 2002 Pesticide/Herbicide Usage List for PBS

Name	Chemical Name	Manufacturer	Type*
Hyvar XL	Lithium Salt of Bromacil	Riverside Services	H
Spike 20P	tebuthiuron	Dow AgroSciences LLC	H
Glyphomax Plus	glyphosate	Dow AgroSciences LLC	H
Reward	diquat dibromide	Zeneca Professional	H
Dacamine 4D	dichlorophenoxyacetic acid	SDS Biotech	H
Bk 800	dichlorophenoxyacetic acid	Gordon	H
Hi Dep IVM	Dichlorophenoxyacetic acid	Gordon	H
Crossbow	dichlorophenoxyacetic acid	Dow Elanco	H
Roundup	glyphosate isoproylamine	Monsanto	H

*H=herbicide (no insecticides are used)

B11 RADIOACTIVE MATERIALS AND NON-IONIZING RADIATION

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to ionizing & non-ionizing radiation sources. Relevant chapters include:

- Chapter 28 Ionizing Radiation Protection Program
- Chapter 29 X-Ray Equipment
- Chapter 30 Non-Ionizing Radiation

GRC's Radiation Protection Program establishes the administrative requirements and health physics practices and procedures for facilities and users of ionizing radiation sources and equipment, at Plum Brook Station. The Radiation Safety Officer (RSO) resides at Lewis Field and provides oversight for both locations. The safety permit process, Radiation Safety Committee, along with health and safety inspections help to promote the standard for protection against radiation exposure.

B11.a X-Ray Generating Equipment

There are two inactive nuclear reactors in the Plum Brook Reactor Facility (PBRF), the Research Reactor (a 60 MW pressurized reactor) and the Mock-Up Reactor (a 100 kW swimming pool type reactor). The reactors ran from 1961 to 1973, and were then defueled and placed in dry storage until 2002, when the NRC approved NASA's Decommissioning Plan. Decommissioning activities are currently underway, with the goal of achieving unrestricted release from the NRC licenses (less than 25 mrem annual dose above background to a resident farmer through all pathways) by 2007. Only trained and qualified radiation workers are allowed close enough to the source to be at risk. No member of the "general" staff, let alone the public, is at risk of any exposure from the reactor or decommissioning.

Four smaller, but significant radioactive sources stored onsite are covered under a separate NRC Material License No. 34-00507-16. This license is for small sealed sources only. This license was renewed in 1996 and extended until June 30, 2004.

PBS has two Cesium gauges in storage and none in use at this time.

Exposure potential for sealed sources and x-ray equipment, for members of the public is highly unlikely. Occupational workers have a low probability of exposure while changing/positioning target materials or performing maintenance on equipment, unless the shielding fails or is removed.

Radiography is done at PBS and has the potential for exposing the greatest number of members of the public or employees, due to the fact that the procedure cannot always be performed in a shielded facility. PBS does not have a shielded facility. When it is not possible to transport parts to the radiography facility, exposure is controlled by maintaining appropriate radiation levels at a safe distance from the source, and limiting access to the area with barriers and warning signs.

Contractor radiographers are required to provide GRC's RSO a copy of maintenance, training, instrument calibration records, leak test records, licenses and all other applicable requirements for the procedure being performed and the type and strength of the source being used. GRC's radiographer is required to provide annual maintenance records to the RSO for the portable x-ray units, which are operated at Lewis Field and PBS.

There are no non-ionizing radiation sources at PBS except for low-level electromagnetic field sources associated with transformers and power supplies.

B12 NOISE, SONIC BOOM, VIBRATION

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related noise impacts. Relevant chapters include:

- Chapter 11 Hearing Conservation Program

Occupational exposure to noise is regulated by OSHA at 29 CFR Part 1910.95. The noise exposure limit for workers is 90 dB (A) as a maximum daily time-weighted average. (The "decibel-A" scale, written as dB (A), is a frequency weighting network representative of the response of the human ear.) NASA has set a more conservative worker exposure limit of a time-weighted average of 85 dB (A).

B12.a Environmental Setting

The land surrounding PBS is largely agricultural or rural. The nearest public gathering receptor facilities are generally more than 305 meters (1,000 feet) removed from PBS's boundaries, and much more distant from the noise generators on the PBS site. These receptors include: a church along U.S. Highway 250 and a church on Bogart Road; a school on Campbell Road north of Bogart Road; and a school on Mason Road just west of U. S. Highway 250.

B12.b Plum Brook Station Operations

Sources of noise at PBS include an unpaved airstrip which accommodates light aircraft, transient noise blasts from test facilities, construction activities, and traffic noise. The Army Reserves and the Ohio Air National Guard occasionally discharge pyrotechnic devices at PBS. None of these activities is believed to be a significant source of noise impacts.

This, combined with the infrequent operation of facilities, and the distances to offsite receptors, mitigates any noise impacts the facility may create. No noise complaints against the PBS have been noted.

The *Environmental Justice Implementation Plan* (Jones, 1996) concluded there was "...no reasonable likelihood of substantial sustained off-site noise impacts from normal operations and only moderate likelihood of substantial off-site noise impacts from emergency operations or reasonably foreseeable accidents such as explosions or fires."

B13 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL FACTORS

The Glenn Research Center Environmental Programs Manual contains detailed policies and procedures related to historic and archaeological resources. Relevant chapters include:

- Chapter 36 Cultural Resources

B13.a Historic Setting

In 2002, Gray & Pape, Inc., was retained by SAIC to conduct a Phase I architecture survey at PBS. The Area of Potential Effect for the project included all National Aeronautics and Space Administration or General Services Administration owned or leased structures located within and adjacent to PBS.

Two of the facilities at PBS have been previously documented as eligible and not eligible for landmark status. The two facilities are the B-2 (the Spacecraft Propulsion Research Facility) and the PBRF. The B-2 facility is a National Historic Landmark (listed in 1984). PBS's B-2 Facility is the world's only facility capable of testing full-scale upper-stage launch vehicles and rocket engines under simulated high-altitude conditions. The engine or vehicle can be exposed for indefinite periods to low pressures, low-background temperatures, and dynamic solar heating, simulating the environment the hardware will encounter during orbital or interplanetary travel.

The PBRF was determined not eligible for listing in the National Register of Historic Places. NASA, however, is in the process of documenting for historical purposes the reactor facility through a three-year contract with History Enterprises, Inc.

The Phase I architecture survey for the PBS project was conducted in April 2002. The survey documented and photographed 265 buildings. These buildings or complexes are summarized on 72 Ohio Historic Inventory forms. As a result of this survey, Gray & Pape recommended that the Space Power Facility is potentially eligible to the National Register of Historic Places. The Space Power Facility (SPF) houses the world's largest space environment simulation chamber, measuring 30.5 meters (100 ft) in diameter by 37.2 meters (122-ft) high. The facility was designed and constructed to test both nuclear and nonnuclear space hardware in a simulated low-Earth-orbit environment. Some of the test programs that have been performed at the facility include high-energy experiments, rocket-fairing separation tests, Mars lander system tests, and International Space Station hardware tests.

B13.b Archeological Resources

In 2002, Gray & Pape, Inc., was retained by SAIC to develop a model for predicting the archaeological sensitivity of NASA's 2,590 hectares (6,400 acre) at PBS. The Area of Potential Effect for the project included all NASA-owned or -leased land located within and adjacent to the Station.

The following text is an edited excerpt from *Predictive Model and Ground-Truthing Survey of Prehistoric and Historic Archaeological Resources at the NASA Plum Brook Station* (Gray and Pape, 2002).

> *A number of archaeological investigations have occurred near the project area, including a Phase I survey along U.S. Route 250 (Skinner et al. 1981), sections of a Phase I survey relating to modifications to Interstate 80 (Bush et al. 1981), Phase I and II investigations of two parcels of NASA-owned land (Blank 1984), Phase I investigations of NASA-owned excess property (Pratt and Croninger 1981), Phase I investigations of several discrete areas near K Site (Stevens and*

Kohring 2000), and sections of a Phase I Literature review conducted for a cable alignment that was proposed to run south of the facility (Skinner et al. 1988).

The main pattern that emerges relevant to the project area includes the extensive cultural activity immediately south of PBS. The investigations by Pratt and Croninger (1981) examined an area between the facility fence line and Mason Road to the southwest of PBS, and along the western boundary of the facility. During their research, they discovered a total of 126 sites spanning all prehistoric periods. The majority of these sites related to extraction and reduction activities associated with Pipe Creek chert, which crops out in the area (Pratt and Croninger 1981: i). The remaining resources appeared to relate to seasonal hunting and gathering activities. Pratt and Croninger noted that culturally identifiable artifacts in the southern section of the project area lessened by the Late Archaic, when rising lake levels began to inundate many of these areas (Pratt and Croninger 1981: 21). To the north of Fox Road, they reported a greater proportion of larger-sized camps dating to the Woodland periods, consisting of lithic debris representing hunting and habitation activities, ceramics, and grinding stones and other ground stone tools (Pratt and Croninger 1981: 22). In sum, the previous research indicates that the extensive prehistoric use of the landscape from the Archaic through Woodland periods centered on the extraction of Pipe Creek chert and its modification into usable implements. Additional work by Huntly (1981) suggests that the vein of Pipe Creek chert continues with the Prout Limestone formation, which has a northeastward trend and roughly parallels Taylor Road (Huntly 1981: 39).

Work by Blank (1984) consisted of Phase I investigations in two discrete areas. The first (Area 61) consisted of a triangular patch of land within the bounds of PBS, defined by Patrol Road to the south, South Magazine Road on the north, and Taft Road to the east. The second (Area 62) consisted of a square parcel outside the bounds of the facility, defined by Mason Road to the south, the facility fence line to the west, and two arbitrary lines north and south. In total, Area 62 comprised of 12.5 hectares (31 acres) (Blank 1984: 1-2). Results of his investigations included the documentation of 28 previously unknown prehistoric sites, all of which appeared to be small-scale workshops or campsites. No assignment to a temporal affiliation was possible.

The third survey within NASA-owned land consisted of Phase I investigations in four discrete areas (5.6 hectares [14.01 acres] total) near K Site (Stevens and Kohring 2000). Results of these investigations included the discovery of two isolated finds (33Er490 and 33Er492) and one site (33Er489) that consisted of two flakes. These sites were assessed as not eligible for listing in the NRHP.

Additional archaeological investigations were undertaken at the Lewis Field and PBS project areas during November 2002. The additional Phase I archaeological field investigations were conducted to support recent changes in Cleveland Hopkins Airport expansion plans. A total of 1.2 hectares (3.1 acres) at PBS were surveyed for evidence of cultural materials. No archaeological deposits or other significant cultural remains were encountered during the November 2002 field investigations.

By combining the previous work of Pratt and Croninger and Blank, a preliminary hypothesis regarding the type and distribution of sites within PBS develops. The main vein of Pipe Creek chert crops out immediately to the southeast of the facility, and dense artifact scatters were located in this section from Mason Road north to Fox Road. Since the formation runs northeast, it can be suggested that this trend would continue into PBS, both in the area bounded by Fox and Ransom Roads, and in a diagonal swath parallel to Taylor Road. In addition, the work by both

Blank and Pratt and Croninger mention the heavily inundated nature of the local terrain, owing (according to Pratt and Croninger) to the rising water table in the Late Archaic.

During the 2002 survey data were collected for an 869.83-square-kilometer (214,938-acre) area encompassing the station to help place the study areas in an appropriate context. Data sets used to develop the model included soil associations, water sources, geological resources, and previously recorded sites. These factors were mapped in a Geographic Information System using both standard 7.5 minute United States Geological Survey maps and NASA-provided maps of the facility. The model identified areas of low, medium, and high sensitivity for archaeological sites, and projected those sensitivity layers onto the study area.

During April 2002, ground truthing of the model was initiated. Results of this ground truthing indicated a correspondence with the hypothesized results. Based upon this work, the model is seen as a useful guide to understanding the possible site location densities at the facility.

A total of 13 archaeological sites (33Er500 – 33Er512) were identified during the ground-truthing survey of PBS in 2002. Six of these resources were isolated finds of prehistoric lithic artifacts or low density lithic artifact scatters. Several sites contain a high density of artifacts and represent area where the reduction of local raw material took place.

Six isolated finds were recorded during ground truthing. These sites were identified in all areas of the project area. Only multi-artifact sites will be described.

The remaining seven sites were located throughout the project area, although a preference is implied by their location near local streams and lithic resources. No resources (except for the isolate at 33Er510) were found in the eastcentral or southeastern sections of the facility.

Table B13-1 contains a list of multiartifact sites identified by Gray and Pape in 2002.

NASA anticipates the development of a comprehensive plan for managing all cultural resources at PBS sometime in the near future.

A13.c Cultural Institutions in the Vicinity of Plum Brook Station

The nearest public gathering facilities are generally more than a 1,000 feet removed from PBS's boundaries, and much more distant from the noise generators on PBS. These receptors include: a church along U.S. Highway 250; a church on Bogart Road; a school on Campbell Road north of Bogart Road; and a school on Mason Road just west of U. S. Highway 250.

Several natural areas are found in the general vicinity. The Milan State Wildlife Area is located approximately three miles to the south. The Erie Sand Barrens State Nature Preserve is approximately 305 meters (1,000 feet) to the south. The Sheldon Marsh State Nature Preserve is approximately four miles to the northwest, and the Resthaven Wildlife Area 9.6 kilometers (six miles) also to the northwest. Another local natural area is Old Woman Creek, a National Estuarine Research Reserve and State Nature Preserve, which is east of the City of Huron.

Table B13-1 Multiartifact Sites

Ohio Archeological Inventory Number	Study Designation	Description of Findings*
33Er500	Field Site 1	Site 33Er500 was identified in Area 009 (Figure B20), and measured 45 by 45 meters (148 by 148 feet). The assemblage consisted of 33 pieces of flaked stone, 7 of which were found in the subsoil.
33Er501	Field Site 2	Site 33Er501 was located in Area 133 (Figure B27), and measured 40 by 40 meters (131 by 131 feet). The assemblage consisted of 238 pieces of flaked stone, 105 of which were found in the subsoil.
33Er502	Field Site 3	Site 33Er502 was identified in Area 130 (Figure B26) and measured 7.5 by 30 by meters (24.6 by 98.4 feet). The assemblage consisted of 2 pieces of lithic debitage. The flake types from Site 33Er502 included 1 secondary flake recovered from Stratum II in Shovel Test C1 and 1 shaping/finishing flake recovered from Stratum I in Shovel Test B1.
33Er503	Field Site 4	Site 33Er503 was found in Area 137 (Figure B28) and measured 60 by 60 meters (197 by 197 feet). The assemblage derived from Site 33Er503 consisted of 277 pieces of lithic debitage, all of which were manufactured from Pipe Creek chert.
33Er504	Field Site 5	Site 33Er504 was found in Area 019 (Figure B22) and measured 15 by 45 meters (49.2 by 147.6 feet). The assemblage derived from Site 33Er504 consisted of 25 pieces of lithic debitage, all of which were manufactured from Prout/Pipe Creek chert.
33Er507	Field Site 8	Site 33Er507 is a dense prehistoric artifact scatter found within Area 020. The site measured 60 by 60 meters (98 by 98 feet). The assemblage from Site 33Er507 consisted of 592 pieces of lithic debitage, all of which were manufactured from Pipe Creek chert.
33Er511	Field Site 12	Site 33Er511 is a mixed historic and prehistoric scatter that was identified during shovel testing of Area 301 (Figure B32). The historic assemblage derived from Site 33Er511 consisted of 15 artifacts including light Aqua glass (n=9), undecorated ceramic (n=5), and 1 piece of metal. The prehistoric assemblage consisted of a single blocky fragment of Prout/Pipe Creek chert.

* Gray and Pape, 2002

B14 ECONOMIC, POPULATION, AND EMPLOYMENT FACTORS

B14.a Population of the Sandusky Area

The 2000 Census lists the population of Erie County at 79,551, with 35,909 total housing units. The population is 88.6% White, 8.6% African-American, 2.1% Hispanic, and the remaining 0.7% consisting of Native American, Asian and Other. The median age is 40 and the average household income is $28,210. The 2000 annual civilian workforce for Erie County is listed as 42,500 with 40,600 employed for an unemployment rate of 4.4%. The services industry employs the most people followed by manufacturing, trade, government, construction, transportation/utilities, finance/insurance/real estate, agriculture/forestry/fishing and mining. The location of Erie County next to Lake Erie and the local attractions make the county a high tourist area. The population in the area increases by 50% in the summer. Cedar Point Amusement Park alone draws approximately 3.6 million visitors each season. The largest city is Sandusky with a population of 27,844.

B14.b Environmental Justice

Information regarding PBS's Environmental Justice Implementation Plan can be found in GRC Lewis Field Chapter A14.

The Environmental Justice Implementation Plan found "no substantial or disproportionate environmental impacts are currently experienced by any community at either [Lewis or PBS]." The Plan identified six Census tracts within an 8 kilometer (5 mile) "region of influence" from PBS which are likely to meet Federal environmental justice criteria for minority or low-income communities. The locations of these tracts (highlighted in yellow) are shown in Figure B14-1. The Plan is being implemented to identify and mitigate potential environmental justice problems and will be revised periodically as needed.

B14.c Health and Emergency Services and Transportation

Health, emergency, and fire services are provided by Perkins Township under an informal cooperative agreement. This may be formalized in the future in a written agreement. The nearest hospital is Firelands Community Hospital in Sandusky approximately 8 kilometers (5 miles) from PBS. Staff at the PBS Plant Protection Office are trained to administer emergency first aid and CPR.

The PBS includes a 101 kilometer (62.5 mile) internal paved road system. There is also a 25 kilometer (15.7 mile) rail line which is currently unused (Morrison Knudsen 1994). Several State roads service the area including Rte 2, north of PBS, which is a major thoroughfare between Cleveland and Toledo, and the Ohio Turnpike (Interstate 80 and 90) located just to the south. Traffic is moderate in the winter but increases dramatically during the summer tourist months because of local area tourist attractions.

B14.d Labor Force

Peak NASA employment at the PBS was approximately 600 people in the mid-1960s. Today total NASA employment is approximately 100. Of these, approximately 14 are civil servants and the remainder are contractor employees. Other government agencies have 20-30 personnel stationed on site.

The PBS is not as significant an employer in its region as is the Lewis Field site. Other large employers in the area include the Ford Motor Company, Delco-Chassis NDH, Imperial Clevite, Sandusky Plastics, and Sandusky Foundry and Machine. NASA's presence in the area provides local economic impacts and benefits nonetheless. A 1996 study found overall economic benefit to the regional economy from NASA

GRC to be: total output of $1 billion, employment impact of 12,800, and household earnings impact of $375 million (Austrian, 1996). Most of these benefits are associated with the Cleveland facility (the study did not disaggregate results by site), however GRC actions are felt throughout Ohio. Some 40% of GRC's annual $600-$700 million in consumption of goods and services is spent in Ohio. GRC awards $43 million in grants to schools and universities of which $6 million is spent in Ohio.

B14.e Electric and Gas Utilities

Electric power for the PBS is supplied by the Ohio Edison Company. Backup generators are available for emergency power. Natural gas is supplied by Columbia Gas of Ohio and is used for space heating and testing purposes.

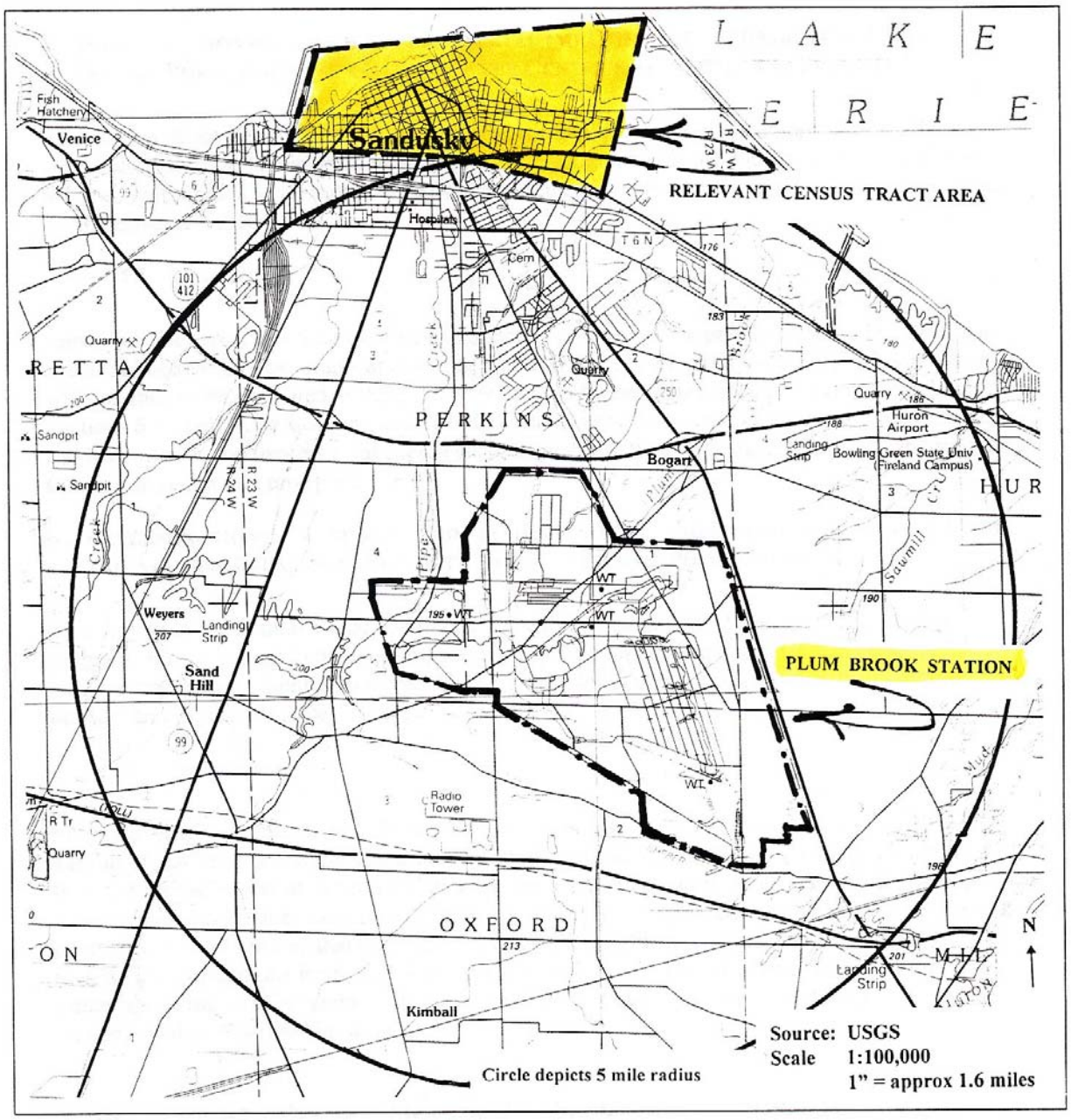

Figure B14-1 Possible Minority and Low-Income Areas Near PBS Based on 1990 Census (outlined in bold)

B15 SPECIAL LAND USES IN THE VICINITY OF PLUM BROOK STATION

B15.a Special Land Uses

PBS is located in an area with urban-type development associated with the City of Sandusky predominating to the immediate north, while agricultural (farming) operations and dispersed single-family residences on larger lots predominate to the west and south. The Erie County Perkins School District currently uses certain former NASA facilities, located near the main gate and outside the fenced area, for transportation and storage purposes. Intensive commercial development, consisting of highway-oriented uses (e.g., motels, restaurants, service stations) and shopping malls, predominate immediately to the east along U.S. Highway 250 and its intersections with Bogart Road and State Highway 2 in Sandusky.

Activities along U.S. Highway 250, which parallels PBS on the east, consist of a mixture of dispersed residential, commercial and industrial uses, in addition to farming operations, from Sandusky southward to Mason Road (County Highway 13), which parallels a portion of the southern boundary. In addition, the Erie County Conservation League, a youth-oriented organization, is located adjacent to the northeastern boundary on the west side of U.S. Highway 250. A U.S. Army Reserve Center is situated adjacent to the southeast corner, just off Mason Road.

The closest refuge to PBS is the Ottawa National Wildlife Refuge complex which consists of three wildlife refuges – Ottawa National Wildlife Refuge, West Sister Island National Wildlife Refuge and Cedar Point National Wildlife Refuge. These refuges are more than 25 miles from the station and operations at PBS are unlikely to affect them. In addition to the wildlife refuges, Old Woman Creek Reserve near Huron is part of the National Estuarine Research System and is the only Great Lakes-type, freshwater estuary in the system. This Reserve is approximately seven miles from PBS. It is also a State Nature Preserve. The Erie Sand Barrens State Nature Preserve is located adjacent to Taylor Road, just to the south of the southern boundary of PBS.

There are no National Seashores in the vicinity of PBS.

The closest Ohio Scenic River is a 65 mile stretch of the Sandusky River between Harrison Smith Park in Upper Sandusky and the Roger Young Memorial Park in Fremont approximately 25 miles southwest of PBS. This section of the Sandusky River is unaffected by the groundwater or surface water discharges from PBS.

The only National Park close to PBS is the Perry's Victory and International Peace Memorial on South Bass Island in Lake Erie. There are seven state parks located on the Lake Erie mainland coast or on the offshore Lake Erie Islands. The closest of these parks is approximately eight miles from PBS. These State Parks cater to recreational activities centered around Lake Erie including boating, camping and picnics.

The closest hospital is Firelands Community Hospital located approximately 5 miles from PBS.